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RETURN TO 201 MARKET ST.
GENERAL
SUPERINTENDENT'S

POWER PLANT OF THE NEW YORK STOCK EXCHANGE

A Plant in which Heating and Ventilating are the Important Factors

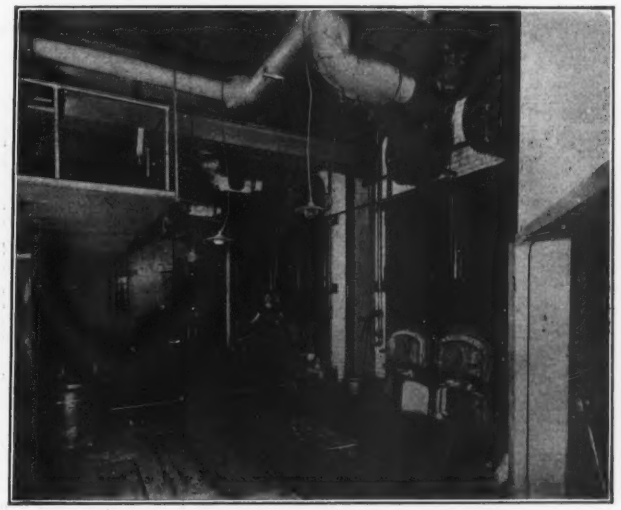
There are many famous buildings in New York City, but the one to which every financier throughout the world turns his eye each day, and the one building which a stranger to New York City rarely misses is the Stock Exchange building. While the new building is one of the architectural features of the city, it is not that alone which makes it attractive, but everybody wishes to see the game of millions being played upon the trading floor, where the nod of the head or the shake of a finger changes a few million dollars from one pocket to another. While the brokers on the floor are merely the instruments which the captains of high finance use to accomplish their ends, yet to the popular mind the noise and confusion incident to a busy day on the floor are very much more realistic than the inner mahogany office of the multi-millionaires, among whom the real game is being played.

The building is located on Broad, New and Wall Streets and consists of fourteen stories from the cellar upward. The cellar is three stories underground, next to which comes sub-basement No. 2, sub-basement No. 1 and basement, the latter being only partly below the street level. The board room floor is immediately above this and is 86 feet in height. There is a gallery for visitors and four mezzanine floors. Above these floors are the bond and club-room floors and several other floors used for minor purposes.

The mechanical plant is located in the cellar, the boiler room and engine room being partitioned off from the rest of the cellar. At one end of the boiler room there is a 150-ton coal bunker which receives its coal from chutes from the street level. Next to the boiler room is the engine room whose floor level is 5 feet higher than the rest of the cellar, thus allowing room for steam, exhaust and other pipes underneath. The elevator pumps are set along the boiler room wall and the house and fire pumps, the water filters, the sewage lifts, the auxiliary electric generating unit and the tanks and compressor for pneumatic tube service are distributed between boiler room and ventilating apparatus. The ventilation and refrigeration apparatus take up the remaining large part of the cellar.

The boiler plant consists of four Babcock and Wilcox water-tube boilers, averaging 200 horse power each. They are hand fired with pea coal, the coal being brought from the coal bunker in narrow-gauge cars. Steam at an average working pressure of 125 pounds is taken from the front end of the boiler drums of each boiler and is carried horizontally across the firing space to a 12-inch header. These pipes between boilers and header are equipped with two valves, one at the boiler and one at the header. The header is also equipped with a valve which divides it into two parts.

From the 12-inch header, one 10-inch line goes to the engine room, an 8-inch line supplies the reducing valves for the low



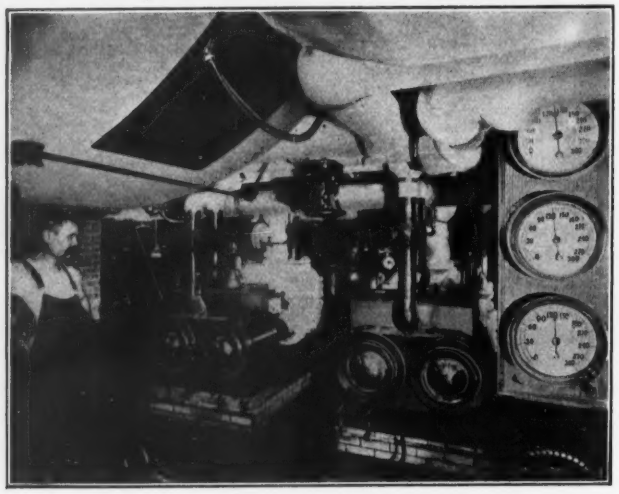
Boiler Room in New York Stock Exchange Building

pressure systems, used for both heating and cooking purposes, and a 6-inch main supplies the pumps. From the other end of the header, a 6-inch main is also run to the pump line, so the pumps are assured of a double supply of steam. The pump main also supplies an auxiliary generating unit in case of any accident to the engine room system. This unit is only large enough to operate the ventilating fan motors and a moderate amount of lighting such as is required after regular hours or during Sundays. The steam in going from the boilers to the engines passes through two separators, one of the Potter mesh type being placed in each steam drum of the boiler and

a large Stratton receiver separator 36 in. in diameter and 9½ feet high being placed on the main line.

The engine room, which is floored with small dark-red tiles, contains three direct connected units, two of 250 kilowatts and one of 150 kilowatts capacity. The engines are Ball and Wood tandem compound, the larger engines being 18″ and 31″ by 18″ and the smaller engine 13″ and 26″ by 13″, the speed of the larger engines being 175 revolutions, while the smaller engine runs at 225 revolutions per minute. The engines run non-condensing, the exhaust steam being used for heating in winter and for refrigerating purposes in summer. The generators are of the General Electric multipolar type and run at 240 volts, which voltage is desirable for the large number of motors throughout the building. In connection with the generators which carry the heavy day load, there is a storage battery set installed which is used to carry the lighter loads during afternoon and at night. The batteries are of the Electric Storage Battery type and are of 800 amperes hour capacity. A Western Electric 15 horse power motor-generator set is used for charging.

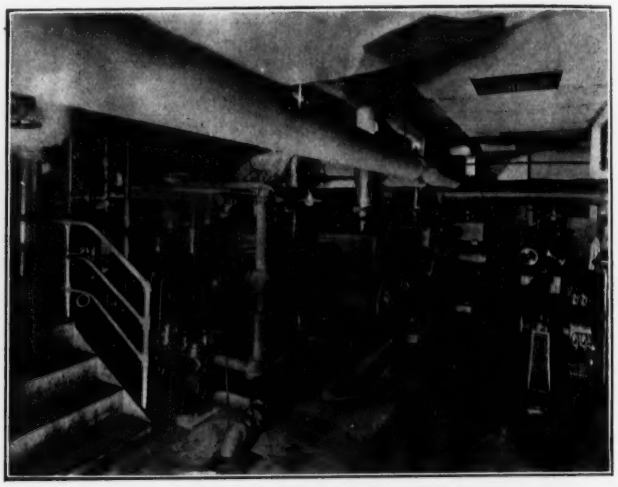
The switchboard is situated close to the generators and consists of the usual equipment of voltmeters, ammeters and wattmeters. There is also an extensive gauge board in the engine room with a gauge for each boiler, gauges for the pressure on the lines of the humidifier coils for ventilating system, gauges on lines to kitchen, for refrigerating system and heating system. The oil pressure system for lubricating the engine is also installed in the engine room. The system consists of four small pumps, two being used as duplicates. One pump connects to the cylinder oil pressure tank overhead and maintains the pressure at 160 pounds, while the other pump keeps the engine oil under a pressure of 100 pounds per square inch.



Brine Pumps in New York Stock Exchange Building

All the pumps for elevator service, feed and return pumps, house pumps, fire pump, blow-off and drip pumps, air compressors and sewage ejectors are located in the pump room. The main pumps for the Otis hydraulic elevator system are of the Worthington type, 14 x 20 x 11 x 15 inches in size and automatically maintain a pressure of 150 pounds on the pressure tank. There are six locomotive type Westinghouse air compressors installed, some of which are used to supply air to the pressure tanks, while the others are used to supply the sewage ejectors, which are of the Schone type. The house pump is of the Blake type, 8 x 12 x 17 x 10 inches and the underwriters' fire pump, 12 x 6 x 12 inches completes the collection of large pumps. All the city water used is passed through two filters, which are also located in the pump room.

An important part of this plant is the refrigerating system,



Elevator Pumps in New York Stock Exchange Building

which is located at one end of the mechanical plant in the cellar and is extended through both the cellar and sub-basement No. 2. It is used not only for making ice and for cooling the drinking water and for cold storage boxes used in the kitchen and dining rooms, but the utilization of the cold for cooling and extracting moisture from the fresh air during summer weather is said to be the largest installation of its class in existence. The ammonia absorption system is used throughout, there being three 150 ton machines installed, almost wholly used for cooling the air for ventilation. The machines and equipment throughout were installed by the Carbondale Machine Co. Each machine includes a horizontal generator 52 inches inside diameter and 18 feet long, containing 1300 square feet in twelve coils of 2-inch extra heavy steam pipe, together with an analyzer and an exchanger superposed on it, the analyzer being 39 inches inside diameter and 12 feet high and containing 16 trays, and the exchanger being 36 inches inside and 10 feet high containing 900 square feet of extra heavy pipe coil surface.

The overhead rectifier for each machine consists of three coils of 3-inch extra heavy pipe encased in an open-top tank. The two condensers are each 44 inches inside diameter and 10 feet high, containing 1350 square feet of surface in extra heavy pipe coils. The brine cooler for each set is 52 inches diameter and 11 feet high, containing 1800 square feet of pipe coil surface and the two absorbers are each 44 inches in diameter and 11 feet high, containing 1350 square feet of pipe coil surface.

There are three 16 x 7 x 16 inches direct acting single steam actuated ammonia pumps, one for each refrigerating machine, and two main duplex brine circulating pumps of the Blake pattern 14 x 12 x 12 inches and one auxiliary brine pump 10 x 7 x 12 inches in size. The pressure of water from the city mains forces itself through the condensers and absorbers, after which it flows into a 1200 gallon closed waste or storage

tank, and from this tank it is lifted by a 16 x 12 x 10 inch steam pump to an attic tank for lavatory purposes, any excess of water going to the sewer.

The principal use of the refrigerating system as before mentioned is for the purpose of cooling the hot New York air so that the brokers are always surrounded with an atmosphere in summer which allows their feelings to be unruffled from that source. Altogether, 440,000 cubic feet of room space is cooled in the building together with the 1,200,000 cubic feet of space in the board room. There is 11,000 square feet of exposed glass in this room and 19,000 square feet of exposed wall surface, but notwithstanding these facts, the temperature can be maintained 10 to 14 degrees below that of the surrounding air in the hottest weather with an average humidity below 55 per cent.

To perform this cooling, two stacks of coils are used, made up of 1¼-inch galvanized iron pipe. One stack contains 10,000 linear feet of pipe and supplies the lower floors, while the larger stack contains 20,000 linear feet or 8700 square feet and supplies the board room. The brine is passed through the cooling coils only long enough to get the rooms to the desired temperature during the working day, which is from 10 A. M. to 3 P. M., the frost which collects on the outside of the coils during operation being melted and supplying the air with the proper cooling, large drip tanks being used to catch the water.

The drinking water is cooled from the return brine from the cold storage boxes located on top floors, the brine being circulated in 1¼-inch coils in a galvanized iron cooling tank. The system is designed to cool and filter 400 gallons of water from 80° to 35° per hour. A Loomis-Manning filter is used and a 6 x 4 x 6 inch pump serves to deliver the water to different faucets through galvanized iron mains.

The heating and ventilation system are also designed with great care and ingenuity. The heating is accomplished almost entirely by direct radiation, the fan equipment being used principally for supplying tempered air for ventilation. Exhaust steam from the generator engines and auxiliaries is used for the heating. The 12-inch exhaust main from the generator engines is joined by an 8-inch main from the auxiliaries and they both lead into a pipe 14 inches in diameter, which leads into a muffler tank and feed water heater. Beyond the heater, the pipe continued full size to the distributing drum with a 12-inch branch with a Kiely back-pressure valve opening into the free exhaust riser to the atmosphere. The muffler tank is 48 inches in diameter and 7 feet high and is located at one end of the boiler room. It is of the Potter type with 24 galvanized wire discs to serve as an oil separator. The feed water heater is of the Berryman vertical pattern, furnished by I. B. Davis & Son, of Hartford, Conn.

The distributing heating drum is of cast-iron, 14 inches in diameter. To one end is brought the 14-inch exhaust connection and to the other end a 6-inch live steam connection. The drum has a series of openings at the top which supply the heating mains. To one of the top openings, however, is connected a Kiely reducing valve which supplies the auxiliary live steam, the 6-inch line being used as an emergency. Three steam lines, two of 7-inch and one of 8-inch diameter lead from the distributing drum and are taken to the three groups of tempering coils of the ventilating system, and one 8-inch line is used for direct heating. There are about 8000 square feet of tempering coil surface and about 13,000 square feet of direct radiation.

The condensation from the tempering coils is handled by three 7¼ x 4½ x 6 inch Blake duplex pumps controlled by Kieley pump governors. Three other pumps of the same size, similarly controlled, are used for the high-pressure drips and direct radiation system. One of the pumps handles the condensation collected in the high-pressure drip tank, while the other two act as boiler feed pumps with the suction connected to the system of direct radiation return pipes. All the six pumps connected to the heating system are arranged to deliver water to the boiler feed mains. Make-up water is received from the city mains and passed through coils for cooling the contents of the blow-off and low-pressure drip tanks, the latter receiving greasy water which must be cooled before it is pumped into the sewer.

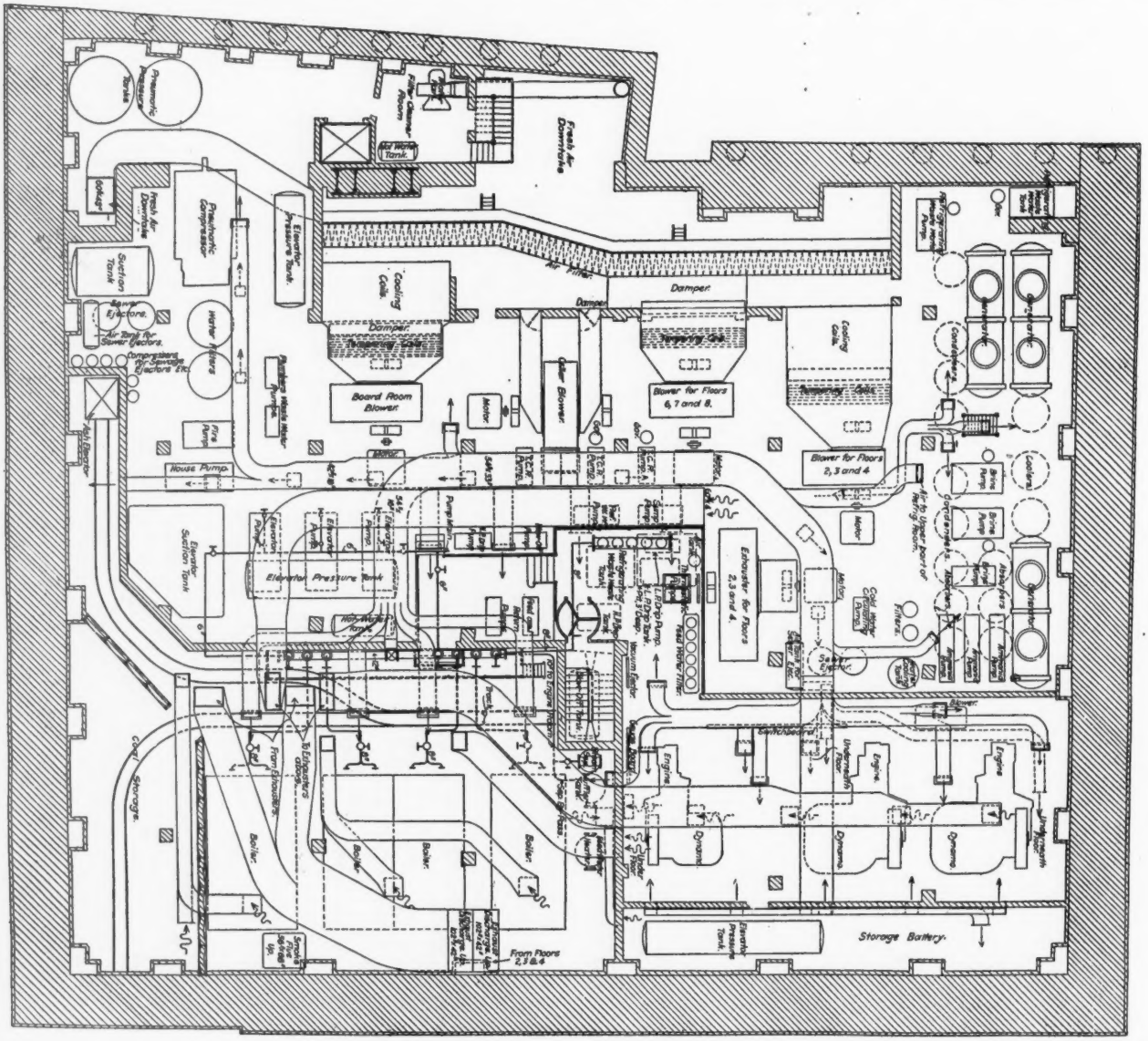
Interior of the New York Stock Exchange

The circulation of the air through the building is maintained by eight centrifugal fans and three disc fans. The air is supplied under a slight plenum and is exhausted by mechanical means which are designed so that a positive outflow of air may take place from the spaces requiring ventilation without creating a tendency for an inflow of cold air from the exterior. The system is divided into independent ventilating sections, the board room, the rented floors below the board room, the mechanical plant, the upper rooms and the kitchen, each being controlled separately. For the cellar system there is a 15 horse power fresh air fan and two 14 horse power exhaust air fans; for the lower floor system, there is one 20 horse power fresh air fan and one 20 horse power exhaust fan;

for the board room there is one 24 horse power fresh air fan and also two 15 horse power exhaust fans; for the upper rooms there is one 20 horse power fresh air fan; for the kitchen there is a 5 horse power disc fan; for the air filter cleaner there is a 4 horse power fan and for the storage battery room there is a small exhaust fan.

All the fresh air fans, with the exception of the small disc fan for the kitchen, are located in the cellar, the fresh air being obtained from a large downtake dropping from roof to cellar. All the fans draw their supply from a common air chamber which is equipped with an air filter. The air filters are of the cheese-cloth type set in frames in a zig-zag fashion. The are of the filter is so designed that the velocity of air through it should not greatly exceed ½ foot a second. About 50 filter frames are taken out each day for cleaning, there being 600 in all, so that the entire filter is cleaned in a period of two weeks. For cleaning the filter sections, a special fan is installed. The suction of the fan and the application of a broom loosen the particles of dust from the cheese-cloth and it is discharged out of doors.

Each of the tempering coils is controlled by a pair of thermostats, one fixed in the cold air duct and controlling two sections of the heating coils first encountered by the cold air and the other in the hot air duct which controls the remaining sections of the heating coils. Each tempering chamber is provided with a moistening pan for maintaining the air, under automatic control of a humidostat at the desired degree of humidity. The pans are placed on the warm side of the tempering coil and are furnished with submerged steam pipe coils to set up evaporation. They are also supplied with an automatic water feed valve for keeping the coils submerged. The humidostat controls the steam coil supply by means of a diaphragm valve taking air from the temperature regulating system.



Plan of Machinery in Cellar of the New York Stock Exchange Building

An interesting feature in connection with this plant is the pneumatic tube system. It is very important that the service

afforded by the exchange to the different telegraph and cable companies shall be identical, so that no company shall receive a quotation a fraction of a second before the others. This makes it imperative that the messages sent from the main tube station must remain in the tubes the same length of time regardless of the length of tube, so that two messages sent at the same time to different parts of the building will be received the same time. There are 97 lines of tubes and the traveling time adapted for all the tubes is 4 seconds. The compressed air is furnished at 30 pounds from an automatically-operated duplex Ingersoll-Sergeant air compressor drawing air from the fresh air supply intakes. It delivers the air into a pair of large storage tanks from which in turn the tubes are supplied. Foster reducing valves are fitted to each end of each tube and the pressure of each is regulated to make the time of transit of the carrier traveling the tube 4 seconds.

The cellar of the building being so far below the surface of the ground contains numerous sump pits which must be constantly emptied by sump pumps. In the early operation of these pumps, great difficulty was encountered, owing to the salty condition of the water, and various chemical means were used without success. It was finally overcome by admitting fresh water into the sump pits, thus reducing the saturated condition of the water. Mr. John H. Dally is the chief engineer of this very intricate plant and he has had to solve many such problems during the operation of the plant.

SOME REASONS WHY STEAM PUMPS FAIL TO OPERATE

Practical Kinks in Reference Thereto

By Wm. Kavanagh.

Steam pumps fail to operate under any or all of the following conditions:

1. Steam valves being lifted from their seats.
2. The seats of the suction or discharge valves being broken.
3. Valve bolts broken or stripped.
4. Valves breaking from excessive use or being allowed to wear too thin to withstand the normal working pressure.
5. Plunger packing too tight or stuffing boxes screwed up too hard.
6. Plunger packing lost or worn away.
7. Plunger followers becoming loose and falling off the rod.
8. When the holes in the valve discs are too large for the holding down bolts or the springs are compressed too tightly.
9. Excessive air leakage in suction or stoppage in suction or discharge ports or pipes.
10. When foreign matter becomes lodged beneath suction or discharge valves.

In the above conditions, the breaking of the valve rods, piston rods or pump arms, loss of water, or steam packing rings becoming loose or broken have not been considered.

Steam valves lift from their seat under the following conditions:

1. If the throttle valve is suddenly opened.
2. If the steam cylinder contains water when piston commences to move, the pressure exerted by the water is liable to cause the valve or valves to become dislodged from their proper position.
3. If the pump exhaust is connected to a heating or other system, the back pressure is likely to be exerted through the exhaust port and lift the valves.

The seats of the water valves may become loose for the following reasons:

1. By being stripped of their threads because they were not properly screwed up, thereby permitting the seat to move at each stroke of the pump, thus allowing the seat to unscrew or wear away the threads.
2. By changing from hot to cold water or the reverse.

Composition valve discs when worn will break across their diameter in almost every case, especially if the pump is changed from hot to cold water or the reverse; also if the pump be allowed to run too fast or the pressure against which the pump is working is excessive.

Whenever the plungers are packed too tight we will be quickly informed of this trouble, because the pump will either refuse to move or if it moves, the motion will be slow and laborious. For this reason, when packing plungers, care should be taken to move the plungers before putting on the cylinder heads. Should the stuffing boxes be packed too tight, the same result will be obtained but, of course, the glands can be loosened or a ring of packing taken out, which will materially assist in lessening friction and obtaining a free moving piston rod.

When screwing up the glands, it should be done so that they will be square; if not, the rods will be worn flat on one side, and when this occurs it will be impossible to pack the stuffing boxes and keep them tight. Sometimes the plungers may be packed with considerable care and an apparently good job done, but for some reason the packing lets go after a few days' wear, after which we must pack again. When this happens, in all probability a portion of the packing will be found beneath the suction or discharge valves and in some cases the packing will find its way into the boilers. If the pump is of the duplex type, the side that loses its packing will have a quick, jerky motion, which is a good indication that the packing is gone. Quick motion of the piston rod will also occur from the valve seat becoming loose or from a broken disc and also if foreign matter becomes lodged beneath the disc. After the plungers are packed and the followers are screwed on, the nuts on the end of the piston rod should be carefully examined for tightness, which will insure the follower from becoming loose.

By screwing down the springs too tightly, the valves will be prevented from lifting their proper height, thus preventing the pump from getting a full supply of water. In like manner, if the valve discs are small for their seats or the holes for the holding down bolts are too large, the pump will have to run rather fast to supply the necessary amount of water. The pump will also race or run too fast if the valves become broken or be lifted from their seats.

STEAM PIPE SUPPORTS

Methods Particularly Adapted to Large Sized Pipes

By R. T. Strohm.

The remarks made in the opening paragraph of an article on "Steam Pipe Supports," by James E. Noble, published in a very recent issue of this journal, are, unfortunately, more fact than fiction. It is regrettably true that there have been numerous instances in which steam piping has been put up in a slipshod and unmechanical manner, in the hope, and with the assurance, that the grosser faults and troubles would not manifest themselves until the system had passed from the hands of the fitters to those of the engineers.

The reason for this state of affairs is not difficult to find. There was a time, not a great while ago, when the steam piping of a plant was looked upon as a minor matter. The engines and the boilers being located, anything in the way of an arrangement that would carry the steam from the latter to the former, without unusual leakage or losses, was considered sufficient. And so it happened that no particularly large amount

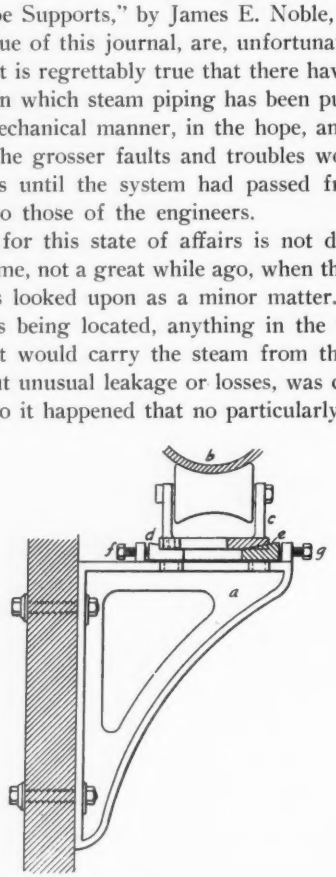


Fig. 1.

of brains or energy was wasted in working out the plans of the piping system.

Nowadays, all this is changed. The experience of years has proved that certain ways are good and that certain other ways are unqualifiedly bad, with the result that infinitely more study and care are devoted to the arrangement and supporting of steam mains and branch pipes than heretofore. The fact that steam pressures have increased rapidly during recent years has had a great deal to do with the increased precautions taken to insure reliable and safe systems of piping; for high-pressure steam is a thing to be feared when once it manages to escape control.

The author of the article referred to described a considerable number of methods of supporting steam pipes, both overhead and underground. The greater number of these, however, are applicable to small pipes, rather than to large mains. For the latter, special forms of support are necessary.

In the construction of any form of pipe support, two points must be kept clearly in mind. First, the support must be strong enough to bear its share of the weight of the pipe and its fittings; and secondly, it should not bind the pipe in such a way as to greatly hinder, or prevent, the longitudinal movement due to expansion, or, perhaps, some lateral motion due to expansion in branch pipes.

Many power plants are arranged so that the engine and

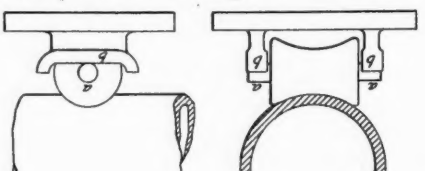


Fig. 2.

boiler rooms lie side by side, separated by a brick firewall. It is customary to carry the steam header along this wall, on the boiler room side, the feed pipes to the engines passing through suitable openings in the wall. In such cases, the main steam pipe, or header, is supported on brackets, which are fixed to the wall. Fig. 1 shows one form of bracket used in this manner.

The bracket proper, shown at *a*, is of cast-iron, and is held to the wall by four bolts which pass through the wall and are fitted with large cast-iron washers on the opposite side, so as to distribute the pull of the bolts over a greater area. The holes in the bracket, through which these bolts pass, are made oblong, so that the bracket may be adjusted, in a vertical direction, in order to properly align the steam pipe.

The pipe, shown in section at *b*, is carried upon a cast-iron roller which turns upon a pin fixed in the frame *c*. This frame *c* rests upon two wedges, *d* and *e*, which may be moved sidewise by means of the setscrews *f* and *g*, thereby raising the

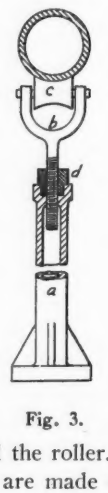


Fig. 3.

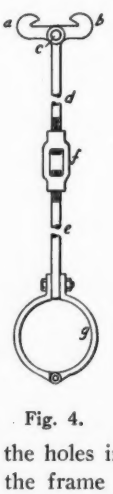


Fig. 4.

frame *c* and the roller. Furthermore, the holes in the top of the bracket are made oblong, so that the frame *c* may have some means of adjustment. The result is that the entire arrangement can be so shifted as to carry the pipe in the proper line without subjecting it to any unnecessary bending stresses.

The pipe being anchored at the middle or at one end, any expansive movement simply causes the roller to turn, and thus leaves the pipe free from binding.

Sometimes, instead of causing the roller to rotate on a fixed pin, the arrangement shown in Fig. 2 is used. Here the journals *a, a* are a part of the roller, and are carried on long, flat bearings *b*. Movement of the pipe in the direction of its length simply rolls the roller along the flat bearing *b*.

In case a pipe is to be supported at some distance from any wall, and it is desired to carry it from beneath rather than by suspension from above, pillars may be used. A form of pillar support is shown in Fig. 3. It consists of a cast-iron column *a*, with a flared base, the latter being bolted to the floor, thus insuring stability. At the upper end is a yoke *b*, carrying a roller *c* on which the pipe rests. The stem of the yoke is threaded, and extends through a nut *d* into the hollow pillar. Adjustment as to height is secured by turning the nut *d*, and the rotation of the roller prevents the column from being tilted over when expansion occurs in the pipe.

It is common, in a great many steam plants, to suspend pipe lines from overhead girders or roof trusses by means of long rods with loops or rings at their lower ends. A form of pipe hanger of this kind, adapted to fastening to an I-beam, is shown in Fig. 4.

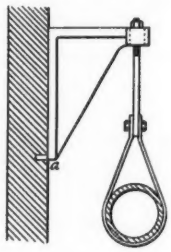


Fig. 5.

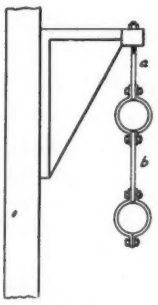


Fig. 6.

Two clips, *a* and *b*, forged to fit the curves of the I-beam, are connected by a bolt *c*, which also serves as a pin to which the suspension rod is attached. This rod is in two parts, *d* and *e*, connected by a turn buckle *f*, each part ending in an eye. To the eye in the lower half *e* is attached the ring *g* which encircles the pipe. The turn buckle, having both right- and left-hand threads, affords the requisite means of adjusting the height of the pipe, within reasonable limits, while the length of the suspension rod, and its flexibility, allow the pipe to accommodate itself to the stresses set up by expansion.

Sometimes it is desired to suspend the pipe by means of rods from wall brackets. An arrangement of this kind is illustrated in Fig. 5. The hole in the end of the bracket, through which the suspension rod passes, is oblong, as shown, so that the pipe may be hung in a straight line, even though there are irregularities in the wall, or slight differences in the dimensions of the brackets.

It will be observed that this bracket has a projecting lug at *a*, which is set into the wall. The purpose of this lug is to take the entire weight of the pipe section, thus relieving the bolts of any shearing stress, their sole purpose being to hold the bracket against the wall and to resist the bending moment due to the pipe weight.

A form of hanger quite similar to this one, but adapted to the support of two lines of pipe from a single bracket, is illustrated in Fig. 6. The rods *a* and *b* should not be less than two feet in length, otherwise any considerable movement of the pipe, longitudinally, will have a tendency to cause a rising at the point of suspension because of the small radius of the arc through which the rods swing.

Still another method of allowing free movement of a pipe is to use a device like that shown in Fig. 7. The pipe rests upon a hollowed casting *a*, whose base is a flat plate. This may move with the pipe. The stationary portion of the support is another casting formed into a shallow box *b*, with a flat bottom. Between the plate and the box are a number of balls, which roll easily and thus allow free movement of the main.

In designing the holding bolts and the suspension rods for the hangers previously shown, there are no difficult calculations. Take, for example, the bolts for a bracket, as shown in Fig. 8. The distance from the top row of bolts to the bottom of the bracket is *d* inches; the horizontal distance from the centre of the pipe to the wall is *s* inches; and the weight of pipe, fittings, covering, etc., carried by the bracket is *w* pounds. Assuming that there are two bolts at the upper end of the bracket, the total pull on each is $w s \div 2 d$. Hence, each must be of sufficient size to withstand this stress, using

Fig. 7.

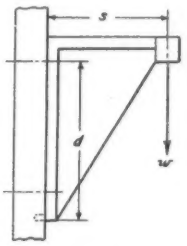


Fig. 8.

a factor of safety of five. The lower bolts do not have much effect in resisting the bending, and they serve mainly to hold the bracket tightly to the wall at the lower end.

In the case of a suspension rod, the total pull many readily be calculated, since it is equal to the weight of that portion of the pipe, pipe covering, valves, etc., carried by the rod. In case a double line is hung, as in Fig. 6, the upper rod must be strong enough to sustain both lines. Knowing the load on a rod or bolt, its diameter is found by using the formula $d = 1.13 \sqrt{w \div f}$, in which *d* is the diameter of the bolt or rod at the root of the threads; *w* is the load in pounds; and *f* is the safe stress in the material per square inch. Having found *d*, reference to a table of standard bolt sizes will quickly show the size of rod required.

Slating for boiler and engine house roofs is usually laid so that the third slate laps the first slate by three inches. To compute the number of slates of a given size required to cover a roof, subtract 3 inches from the length of the slate, multiply the remainder by the width of the slate and divide by two; the result is the number of square inches covered per slate. Divide the area of the roof in square inches by the area covered by each slate and the result will be the number of slates required.

Long-Distance Transmission of Electrical Power

By George E. Walsh.

When Niagara Falls were harnessed only a few years ago, and the electric power conducted to Buffalo, twenty-three miles away, it was a question among engineers which achievement deserved the greater credit—the utilization of the waste energy of the falls, or the successful transmission of the electrical power for commercial purposes to such a distant market. In the enthusiasm of the moment, some newspapers predicted that in time the power of Niagara would reach New York City, and the electric energy generated at the falls would turn all the car wheels and factory machinery within a radius of five hundred miles; but the electrical engineers scouted any such absurd idea, for they realized the great cost and difficulties of sending an electric current over thirty or fifty miles of wire in quantities sufficient to be of commercial use.

The practical limit of electrical transmission appeared to be within sight when Buffalo was supplied with electrical energy from Niagara, and the engineers who had finally tamed a part of the stubborn waters of the great falls proceeded to build up groups of electrical industries within a few miles of their power houses to use the energy they developed. The extension of their wires to more distant markets did not concern them, and working on this assumption, long-distance transmission of electrical energy received no further encouragement at the falls.

But there were other parts of the country which had no Niagara, but which sorely needed current in large quantities for solving perplexing industrial problems. There were waterfalls and high streams and rivers whose head indicated ideal conditions for power development. But strangely enough, nature had located most of these ideal sites for power houses so far from great industrial centres that their usefulness seemed somewhat uncertain. If the industries had to go to the waterfalls and mountain streams, electrical development from hydraulic power had a very limited field. We could not abandon our great coast cities and manufacturing towns and move inland simply to secure cheaper electrical energy. There was only one other alternative. If the mountain would not come to Mahomet, Mahomet would have to go to the mountain.

This was the problem facing the engineers in many parts of the country. On the Pacific Coast, in particular, it was a perplexing question. Coal was scarce and high-priced, and the cost of power production was almost prohibitive on a large scale. It is true that when oil was discovered in large quantities, the question of generating steam power was simplified somewhat; but by this time the electrical engineers had already gone to the mountain streams for hydraulic power, which was destined to revolutionize industrial conditions on the Pacific Coast.

The mountains skirting the Pacific Coast are from 50 to 200 miles back from the ocean, and among their summits are numerous small but powerful streams of water that flow westward. Their great altitude makes them of special value for hydraulic power. Some of them rise two thousand feet above the sea level, and fall in sparkling cascades down steep declivities. Others seek the ocean by a series of sharp declines which make their waters bubble and boil in torrents. The question of harnessing these turbulent mountain streams and conducting electrical power from them to the coast cities has been so satisfactorily solved in the past few years that in no other part of the world are there rivals. San Francisco, Los Angeles, Spokane and other Pacific Coast cities are today drawing their power from the mountains over the longest-distance transmission lines in the country. Even Niagara's achievements are, in a manner, dwarfed by the success of these younger power companies of the Pacific Coast.

We first heard of the achievements of the 83-mile transmission line to Los Angeles. Far up in the Nevada Mountains were Santa Ana River and Mill Creek, two rather insignificant streams that flowed toward the ocean. There seemed to be no earthly value to these streams perched so high up among the mountains and so far from civilization and all industrial centres; but their fall of water was so great that enormous hydraulic power could be developed from them. The harnessing of these two streams was undertaken only after the engineers had made plans for conducting the power to the coast. At the foot of Mill Creek a power house was constructed so that the water flowing down the flume had a fall of nearly 2000 feet, each cubic foot generating thereby 214 horse power per second.

To increase the efficiency of the line, two other power houses were constructed on Mill Creek, and two on the Santa Ana River and connected in multiple to send 40,000 volts across the country to Los Angeles. When this powerful current was introduced into Los Angeles there was great rejoicing and prediction of a great future for the city. Houses and streets were lighted by the power of the inland streams, and the wheels of factories and street railways were run by the same agency. It was the longest transmission of electricity in large current for commercial purposes in the world, and it heralded the beginning of a new era of electrical revolution.

If the current could be sent over 83 miles of country, why not extend it indefinitely? This question immediately received answer by a number of other electrical companies on the Pacific Coast and elsewhere. Hundred-mile transmission lines have been put into operation in the past two years by three different American companies, while two Canadian companies have constructed lines of 93 miles each.

The Kern River Transmission Company essayed to build a line to send 10,000 horse power over one hundred miles, working at a voltage of 45,000 at the power house. In time it was proposed to increase the voltage to 50,000, and the length of the line to 125 miles. The completion of this line further emphasizes the possibilities of sending heavy voltages over wires specially prepared for the purpose. A sixteen-mile line was constructed, and experiments made in sending 80,000 volts over the wires. It was found that 65,000 volts could be sent without giving any difficulty or trouble whatever. As the final limit of long-distance transmission of electrical current must depend upon the amount of voltage that can be developed at the power house and sent over the lines without destroying them, this experiment proved most profitable and satisfactory.

The experiments of the Pacific Light and Power Company with their 80,000-volt Kern River line has thus opened the way for the commercial development of many streams located long distances from towns and cities, and the ultimate end will make revolutionizing changes in many parts of the country.

The completion of the 110-mile transmission line of the Spokane Water Power Company, last year, corroborated the impression that the limits of sending electricity commercially long distances were far from being reached. The power house at the foot of the falls in the Spokane River develops 60,000 volts, and sends the power to the city of Spokane, the line being approximately 110 miles to the furthest power user. The power is sent over three lines, each receiving at the power house about 20,000 volts. There are six substations equipped with water-cooled transformers which can step the voltage down from 60,000 to 4000 volts. The power is used not only by consumers in the city of Spokane, but by mining companies all along the route. At the Standard and Hecla mines four three-hundred horse power electric induction motors drive compressors, hoists and mining machinery. The construction of the long-distance line has completely transformed mining operations along its course. Mines that were formerly impossible from a financial viewpoint are now paying investments. The current is tapped from the main line and used in working all sorts of mining machinery. Owing to the scarcity of coal in this mining region, it was too expensive to attempt to work the low-grade ore, and the change effected by the building of the electric line has been little short of marvelous.

Within the past year the greatest hydro-electric engineering feat of the world was completed by the California Gas and Electric Corporation, which has succeeded in bringing power from the mountains over a line 232 miles long. This is the longest distance over which electrical current has ever been transmitted for commercial purposes. The line stretches from the De Sabla power house in the mountains to Sausalito, opposite San Francisco. The same California company operates another line running from Colgate to Oakland, a total distance of 142 miles, developing at the power house 14,000 horse power from a head of water 702 feet. Closely rivaling this last line is that owned by the Standard Electric Company, which runs from the Electra power house in the mountains to Stockton, San Jose and San Francisco, a distance of 147 miles. The high voltages of all three of these lines range from 50,000 to 60,000.

At the Colgate power house, water is received from Lake Francis through a 9000-feet of 36-inch wooden stave pipe, one-half mile of natural channel, and 3000 feet of rapid flume. The water pours down the pipe with such force that it resembles a great Niagara torrent. Sixteen huge water wheels are turned by it, but the surplus water is allowed to flow unchecked down the incline.

The Colgate power house is the centre of the whole system of this line, and its power has been increased by conducting water from the North Yuba River through nearly 8 miles of wooden flume. The water thus delivered at the top of the hill, 700 feet above the power house, is conducted down the incline as needed. In order to tap the waters of the Yuba, great natural bridges had to be constructed, and the sides of the mountains skirted so that the flume appears to hang on the edge of steep precipices in places. The heavy machinery for the work had to be carted up the steep sides of the hills by dozens of teams of horses, and it took a full month to transport one dynamo a single mile. Elaborate precautions had to be taken to prevent any weakness in the long-distance flume, and watchmen have to inspect every part of it frequently. The force of the water at the power house is so tremendous that only gigantic machinery can pen it in its narrow channel.

Yet in spite of the great outlay for making the line perfect, the commercial profits of the enterprise are great. The sale of the power in the cities and along the line of transmission pays the company for all their efforts. In San Francisco, Oakland, Stockton, Los Angeles and Spokane, electric power can be purchased today cheaper than in most of our Atlantic Coast cities.

The Canadian Niagara Power Company have completed a plant which today develops 60,000 volts at the power house, and current is sent over a transmission line of 93 miles. The Electrical Development Company, of Ontario, has likewise finished a line of 93 miles, and the Winnepeg General Power Company has in operation a 60-mile line, with a capacity of 10,000 horse power and a working voltage at the generating station of 60,000 volts.

In recent years, American electrical engineers have turned their attention with ever-increasing interest to Mexico as a field for possible development. Under the advice and practical work of Americans, Mexican plants have been constructed that compare favorably with any in this country. There are two long lines of transmission in Mexico. One is the Quanajuato Power and Electric Company, which owns a 101-mile transmission line, developed from a head of water 300 feet high, and working under a pressure of 60,000 volts. An even longer transmission line in Mexico is that of the Mexican Light and Power Company, of the city of Mexico, which under a working voltage of 60,000, sends power 110 miles to market. The working head of water for this plant has an altitude above the power house of 1500 feet.

It will readily be seen that American electrical engineers have solved the question of long-distance electrical transmission better than those of any other country, and apparently those working on the Pacific Coast have slightly led those from the East or Middle West. It may be that the peculiar conditions of the country were responsible for this, but certain it is we have no such long-distance transmission lines in the East. We have greater water powers than any on the Pacific Coast, but few lines more than 50 miles in extent. We have harnessed Niagara, and sent its power to Buffalo, 23 miles away; subdued Spiers Falls, and transmitted its energy forty miles away to Troy, Schenectady and Albany; conquered the falls at Massena and delivered enormous current to nearby factories and mills; and built model power houses to utilize the waters of the Sault St. Marie and Apple River, of Michigan. But we still must look to the Pacific Coast for anything like a 200-mile transmission system. It probably will be a long time before the 232-mile transmission line from the De Sabla power house to the coast will be duplicated; but meantime great things may happen in the electrical field, and the tendency is toward the development of higher voltages and longer transmission. Where either will end it is difficult to prophecy today even approximately.

OIL ENGINE ELECTRIC PLANTS AT LIGHTHOUSES

By Frank C. Perkins.

The United States Government has very largely adapted the modern oil engine as a prime mover for the electric plants installed at lighthouses along the coast. The great revolving electric search-lights at the famous "Twin Lights," of Navesink Highlands, N. Y., are supplied with current from two direct-current dynamos driven by belt transmission from two oil engines of the Hornsby-Akroyd type, each having a capacity of 25 horse power. The interior of the electric station is shown in Fig. 1. The current generated for operating the electrical instruments of the Government Wireless Telegraph Station, at Navesink Highlands, is supplied by a dynamo driven by an oil engine of the same type, and similar equipments have been installed by the United States Navy Department, including several of 50 horse power capacity for the U. S. Navy Long Distance Wireless Telegraph Stations in Cuba and Panama.

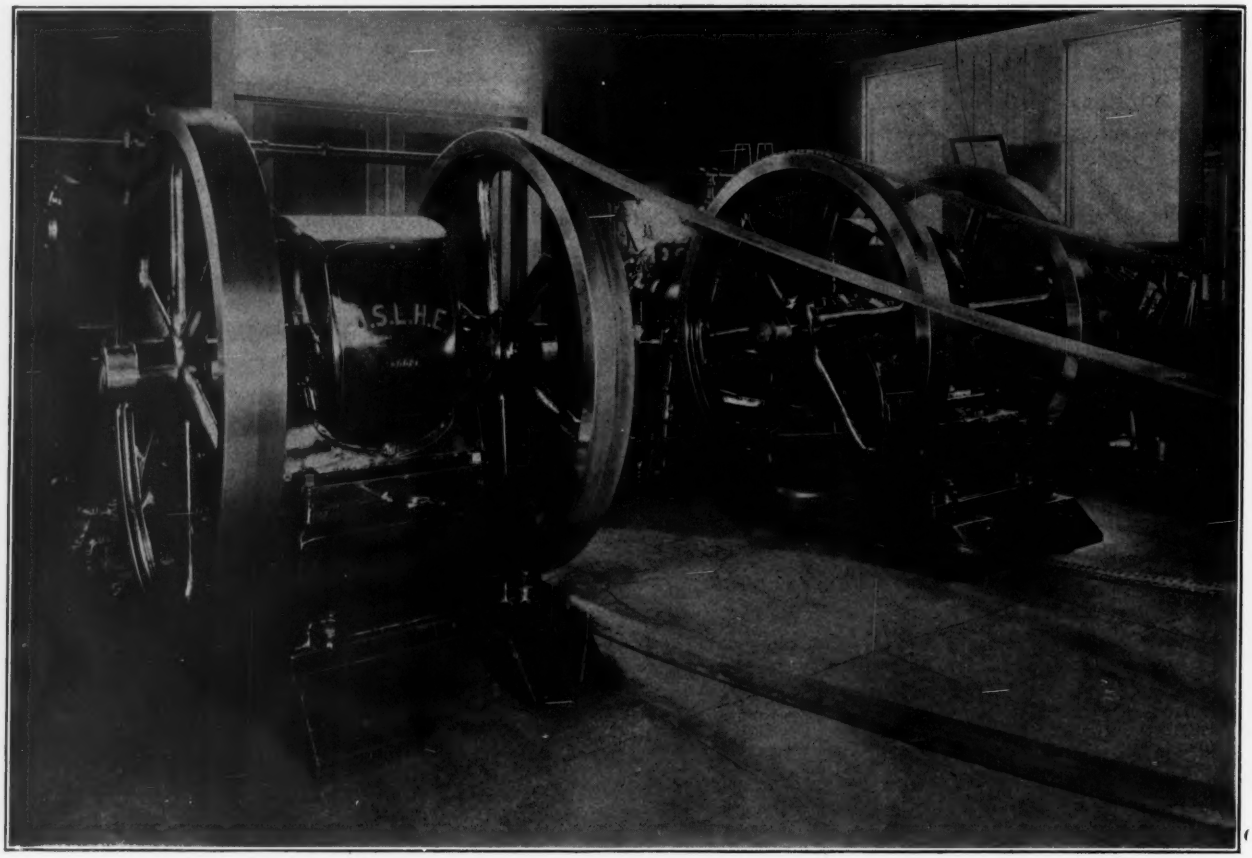


Fig. 1.—Oil Engines installed at the Navesink U. S. Lighthouse, Navesink, N. J., and used to operate the famous Twin Lights

Two 22 horse power oil engines are used at the Marconi Wireless Station, at Cape Cod, Mass., and it is maintained that the work at this station, where the first wireless message was sent across the Atlantic, is exceptionally hard on the engines, the load often changing momentarily from 25 per cent. overload to no load, and vice versa, and the fact that oil engines are doing the work satisfactorily under these exacting conditions is proof of the reliability of this form of internal combustion prime mover.

The accompanying illustration, Fig. 1, and drawings, Figs. 2 and 3, show the details of construction of the simple engines of the "Hornsby-Akroyd" kerosene oil fuel type, as installed at the "Twin Lights," at Navesink Highlands, and the twin cylinder engines of 50 and 60 horse power engines at the U. S. Navy Long Distance Wireless Stations in Cuba and Panama are of similar general construction, consisting really of two simple oil engines securely mounted on a common base, the crank pins being in the same line. The crankshaft of the single cylinder four-cycle engine receives an impulse every two revolutions and therefore in the twin cylinder four-cycle engine, admission takes place in one cylinder while expansion is going on in the other, so that one impulse per revolution is given alternately to each of the two cranks.

The actual cost of power of a 125 horse power oil engine per brake horse power per year is said to be $25.37, with fuel or crude oil at 3 cents per gallon. This is on the basis of 300 working days of 10 hours each and includes $9.27 for fuel, $3.30 for lubricating oil, waste and supplies, $5.00 for attendance and $7.80 per horse power per year for interest on in-

vestment and depreciation at 12 per cent. It is stated that in many localities oil can be obtained for 1½ cents per gallon or less, and in such cases the cost of power would be reduced accordingly.

It is also maintained that the floor space of a 125 horse power oil engine is only 190 square feet or 1.52 square feet

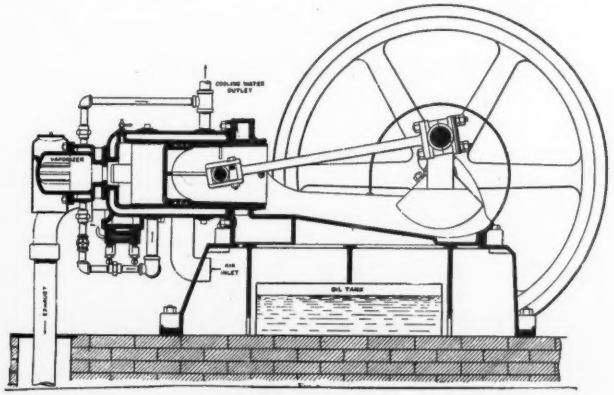


Fig. 2.—Longitudiual Section of Oil Engines used in Government Lighthouses

per horse power, while the floor space for a steam plant of the same capacity would be about 300 square feet, or 2.4 square feet per horse power.

In many of the lighthouses, oil engines are geared to compressors which supply air under pressure for fog signal use as well as for driving electrical generators for supplying current for the electric search-lights. Such a plant is in service at the lighthouse at Little Gull Island; also at the Beavertail Light, R. I., at the Old Orchard Shoal Light and at the Montauk Point Light.

The oil engines used at these plants operate on the four stroke cycle, the exhaust and expansion taking place during two strokes of the piston and the compression and drawing in of charge of air and gas accompanying the other two strokes. The drawing, Fig. 2, shows the construction of the oil internal combustion engine, mentioned heretofore, the air entering the cylinder direct, in the position shown in the drawing, while the oil is injected into the vaporizer, where it is volatilized, due to the high temperature of its walls.

A combustible mixture is formed only after the air is passed into the vaporizer by the returning piston, as the air and oil vapors are in separate compartments. The ignition cannot take place until the charge of combustible mixture is drawn in and compressed to the proper amount. The oil is stored in a tank within the bed-plate of the engine, as noted in the drawing, and this oil is injected into the vaporizer by a positively driven oil pump, while the charge of air is sucked into the cylinder by the outgoing piston, the details of the oil pump and valve gear being seen in drawing, Fig. 3, which shows clearly that the same lever which operates the pump also opens the air valve, and the two operations must therefore occur at the same time.

In order to start this type of oil engine, it is necessary to heat the vaporizer by a Bunsen flame, provided for the purpose, the vaporizer being protected by a hood from the cooling effect of outside currents of air. Compressed air is provided in an auxiliary receiver for starting engines of very large size by a self-starting mechanism. The engine crank is placed a little above dead centre when the automatic starters are employed, and the high-pressure air is admitted to the cylinder through a valve operated by a hand lever, the engine almost immediately taking the load with its own power after one or two revolutions.

A governor of great sensitiveness is provided for regulation, the lever of which works on the bi-pass valve noted in drawing, Fig. 3, allowing a certain amount of oil displaced by the positively driven oil pump to flow back to the reservoir. The amount of oil injected into the vaporizer is thus regulated, the governor cam opening only the small inside valve when operating under ordinary conditions of load.

If the load is suddenly thrown off and there is a tendency for the engine to speed up, the governor-arm not only opens the small inside valve but also a larger concentric valve outside, in which case none of the oil enters the vaporizer, all the liquid fuel being returned to the reservoir under the engine.

It may be of interest to note that at the present time wireless telegraphy is employed to such an extent that many of the larger ocean liners publish daily papers, the news items for which are transmitted from lighthouses and other land stations by long distance wireless apparatus, the current being supplied at these plants from dynamos driven by oil and gasolene engines.

The Stratford Shoal Light Station is equipped with two 4 horse power engines and the South West Ledge Station with two 7 horse power engines. It is stated that the United States Government operates in the Lighthouse Department alone one

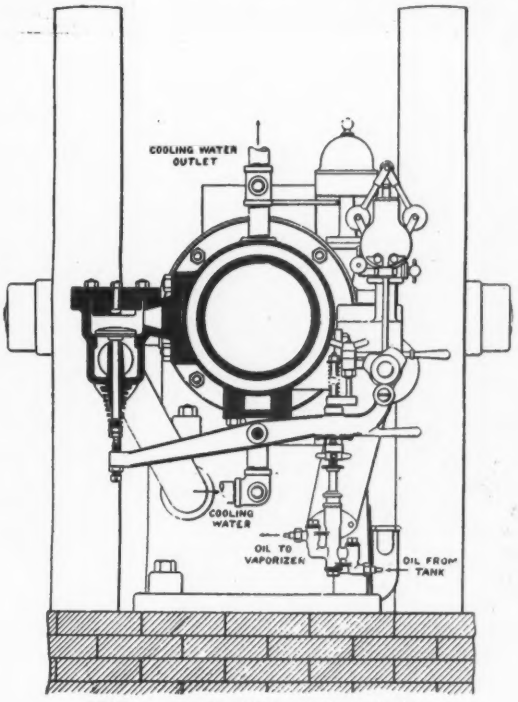


Fig. 3.—Sectional View of Same Engine

hundred and seventeen engines of the oil internal combustion type, having a total capacity of 1124 brake horse power.

It may also be of interest to note some of the details of construction of the oil engines used in these lighthouse plants and the cost of operation. It is maintained that in acceptance tests, many of these engines run on an oil consumption of less than ¾ of a pound of kerosene oil per actual horse power hour.

This high economy is better understood when it is noted that with the expenditure of 1 gallon of kerosene oil, 120 incandescent lamps of 16 candle power can be burned for one hour, and 110 lamps of the same candle power can be burned an hour for each gallon of fuel oil.

The twin cylinder engine is said to possess the advantage that under very light load the oil supply can be reduced or entirely shut off from one cylinder, making it possible to operate the engine with maximum economy under conditions of extremely light load.

THE BOILER EXPLOSION AT TAYLOR, PA.

By C. J. Mason and T. W. Holloway.

In the last issue of this paper a short account was given of the boiler explosion which took place at the works of the Taylor Worsted Company, located at Taylor, Pa. Up to within a short time ago it was impossible to obtain reliable information or photographs, but both of these we have succeeded in getting and they will, no doubt, interest your readers.

Fig. 1

Fig. 2

Fig. 3

The boiler that exploded was one of the four boilers used in the plant and the explosion caused the death of the engineer in charge, injuring two others and wrecking the entire boiler part of the plant. Little or nothing is known as to the cause of the explosion, as the only man who might have been able to shed any light on the subject is dead. So far as can be ascertained, no person connected with the mill knows just what conditions existed in and around the boiler plant shortly before the explosion occurred.

The mill had shut down at 1 o'clock, Saturday afternoon, for a half-holiday. The engine had been stopped and it is presumed that the engineer was attending to his boilers, perhaps seeing that the firemen were banking the fires and that the boilers were filled to the proper level for the shut-down interval. It seems that the mill operatives were formed in line to receive their pay, on the side of the main building farthest from the boiler plant, when at 1.15 P. M. a dull report was heard and almost simultaneously the whole plant quivered as if struck by an earthquake.

One of the boilers had exploded, dismantling and scattering the other three in various directions, wrecking the steam and other pipe connections, smashing the engine, and entirely wrecking the building in which the boiler and engine were, this building having adjoined the main building shown in the accompanying photographs. As will be noticed, the steam plant is a total wreck. The remaining three boilers may possibly be repaired and set up again, but the engine is scarcely worth repairing. The rim of the fly-wheel was boken off from the spokes but remains unbroken as a circular rim of metal.

It is not the purpose of this article to theorize or speculate as to the cause of the explosion, nor to cast aspersions upon any person or persons connected with the plant. That is not for us to say, nor would it be fair for us to do so unless we could investigate and examine all the factors in the case and give careful consideration to every detail. We simply describe what we saw, pictorially and verbally, as an incident in en-

Fig. 4

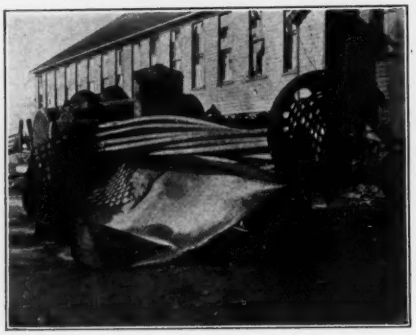


Fig. 5

Fig. 6

gineering life, and taken in the abstract, it may possibly be of interest to the readers of this magazine.

The four boilers, which appeared to be alike in every particular, were made in Oswego, N. Y., in 1898. They are of steel, 5 feet in diameter by 12 feet in length, of the horizontal return tubular type, shell plates $^{5}/_{16}$-inch thick, head plates $^{7}/_{16}$-inch thick, double riveted lap joints, in the longitudinal seam, rivets $^{13}/_{16}$-inch diameter, crow-foot diagonal braces. The working pressure was 90 pounds per square inch and each boiler would probably be rated in round numbers at 50 horse power.

The internal portions of the exploded boiler appeared to be in good condition and free from scale to any extent; there was a slight coating of buff colored scale just about sufficient to protect the plates and tubes from corrosive water. The external portions of all the boilers presented a good appearance. In short, so far as could be seen and judged, the boilers did not show lack of care.

Fig. 1 shows one side of the main building and that part of the ground upon which stood the steam plant annex. This annex was completely destroyed. The exploded boiler and the dismantled ones are shown as found after the explosion. The wrecked engine is also visible at the right hand side of the boilers. Fig. 2 is taken from another view-point and brings out more clearly the havoc wrought. Fig. 3 shows the injuries suffered by the engine. It represents what remains of a 250 horse power Buckeye engine. This view shows clearly the unbroken rim of the fly-wheel although parted from its spokes.

Fig. 7

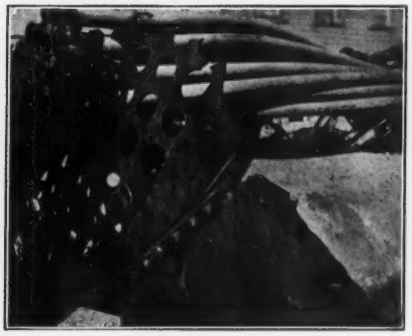


Fig. 8

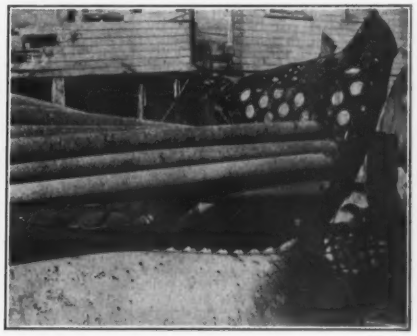


Fig. 9

Fig. 4 shows the type of boilers, plan of riveting and tubes. Fig. 5 shows the burst boiler at close range. The sheets are buckled at the side and those tubes are badly twisted which remained in the heads. One tube sheet remained intact, though bent, while the other was torn asunder, as shown.

The boiler evidently began to rend at the longitudinal seam or just above it and it is thought by some that a crack had developed in the metal there. In the rending of the sheets from the heads, some of the rivets were sheared off, some appeared to have yielded to a tensile stress, some to a partial tensile and shearing stress, while in some places the rivets remained intact and the plates yielded instead.

Fig. 6 shows clearly the sharply-defined buckle or pocket along the edge of the sheet, a little to the left of the centre. What would have caused such an indentation is hard to say, yet it is very noticeable. Fig. 7 shows that the boiler was pretty clean and free from scale, as is evidenced by the clean outlines of the rivets and braces. It also shows that the longitudinal seam remained intact, not a rivet having been disturbed. Fig. 8 is a close range view of the front end of the boiler, showing the line of rend at the upper end of the seam. Part of the lap joint is left, as shown on the flanged head, with one rivet remaining. Fig. 9 shows the back tube sheet and how it suffered and also part of the torn sheet.

The writers of this article are indebted to the courtesy of Mr. M. P. Judge, who is one of the principal owners of the plant, for the privilege of obtaining the photos and also for the information relative to the explosion.

Economy Tests of Large Reciprocating Engines.

An interesting official fifteen-hour test of one of the nine twin vertical-horizontal Reynolds Corliss engines, cylinders 42" and 86" x 60", which have been in operation at the 59th Street Station of the Interborough Rapid Transit Company, New York City, since 1902, was concluded recently. The tests were conducted by the Interborough Rapid Transit Company and representatives of the Allis-Chalmers Company, as a final determination of the fulfilment of the builder's guarantee and formally provided for in the original contracts.

In accordance with the terms contained in the contract between the Allis-Chalmers Company and the Interborough Rapid Transit Company, governing the construction and operation of the nine compound engines in the latter's power station at Fifty-ninth Street and Eleventh Avenue, New York, the former guaranteed certain operative results under specified conditions, in effect as follows:

Each engine was not to require more than 12.25 lbs. of dry steam per indicated horse power per hour, when indicating 7500 horse power at 75 revolutions per minute, with a vacuum of 26 ins. at the low-pressure cylinders, and with a steam pressure at the throttle of 175 lbs., said rating to include all steam used by the engine, exclusive of auxiliaries. A further memorandum agreement formulated by the representative engineers of each company governed in detail the conduct of the test; this secondary agreement being necessitated by certain features peculiar to the case, involving the very essential point of the original contract.

These engines are of the Allis-Chalmers-Reynolds horizontal-vertical type, each with two horizontal high-pressure cylinders, 42 inches in diameter, and two vertical low-pressure cylinders, 86 inches in diameter; all of 60 inches stroke, with the two cranks set at 135 degrees. The high-pressure cylinders have double-beat poppet valves, and the low-pressure cylinders double-ported Corliss valves; all valves being in the cylinder heads. The cylinders were not steam jacketed, and no reheaters were used.

The result of the test so made, under conditions approximating the contract requirements of 7500 horse power, 75 revolutions per minute, 175 lbs. steam pressure and 26-inch vacuum, was a consumption of 11.96 lbs. of dry saturated steam per indicated horse power hour, or well within the guarantee of 12.25 lbs. The steam consumption per kilwatt hour at the switchboard was 17.34 lbs. A summary of test results is as follows:

Duration	15 hours.
Load	5079.2 K. W.
Friction and generator losses	417.3 K. W. = 559.41 H. P.
Total load	5496.5 K. W.
Indicated horse power	7365.3 H. P.
Revolutions per minute	75.02
Steam pressure	175.18 lbs.
Right-hand receiver	19.1 lbs.
Left-hand receiver	19.27 lbs.
Vacuum	26.02 lbs. (actual).
Temp. injection water	42.36 deg.
Temp. right-hand discharge	74.05 deg.
Temp. left-hand discharge	77.38 deg.
Barometer	30.50 lbs.
Water per hour	89.906 lbs.
Drips per hour	512 lbs.
Leakage per hour (boiler)	1470 lbs.
Boiler level correction	60 lbs.
Net water per hour	87,864 lbs.
Quality of steam	100.28 per cent.
Dry steam per hour	88,110 lbs.
Dry steam per kilowatt hour	17.34 lbs.
Dry steam per I. H. P.	11.96 lbs.

The final results allow for boiler leakage, which was determined by a separate test of 24 hours' duration. The steam was very slightly superheated during the test, as being easier to make allowance for than wet steam, and a correction was made to reduce the superheated steam to equivalent dry saturated steam.

The vacuum was carried at 26.02″, or as near the contract requirement as possible, but the barometer stood at 30.50″. The vacuum was, therefore, equivalent to only 25.52″ referred to 30″ barometer; no correction was made, however, as none was provided for in the contract. Other tests at varying vacua show that if the vacuum had been carried enough higher to correspond to 26″ vacuum when referred to 30″ barometer, the steam consumption would have been about 0.09 lb. better, or 11.87 lbs. per indicated horse power hour, instead of the official figure of 11.96 lbs. It is said that the result of 17.34 pounds of dry saturated per kilowatt hour with 25.52 inches of vacuum is the best ever obtained under similar circumstances.

The above tests were made under the supervision of Mr. Frank N. Waterman, who acted as referee. Both the builder and the purchaser were represented by eight representatives on the test.

———o———

The valves of an air compressor should be removed at frequent intervals and thoroughly cleaned. Even when the best oil is used, they will become gummy and dirty in time.

———o———

Black varnish well mixed with turpentine makes a good paint for smoke pipes.

Charging and Starting an Ammonia Compressor.

As each type of ammonia compressor has its own individual features of construction, each particular machine will require special care and adjustment, so that no fixed rules can be laid down to suit all cases. There are, however, some general principles which are applicable to all systems working on the compression system.

Before charging an empty machine with anhydrous ammonia, all air must first be carefully expelled. This is done in various ways. One method often used is to pump the system full of ammonia and shut the engine down. Allow the water to flow in the condensers until all the ammonia in the system is condensed. The liquid ammonia, being heavier, will naturally gravitate to the bottom of the system. A valve can then be opened at the highest part of the system and the pressure of the ammonia will force the air out, the presence of ammonia gas will indicate when to shut the valve. The system can then be allowed to stand another six or twelve hours, and the valve again opened. If there is any air remaining in the system, it will be driven out when the valve is again opened.

Before charging the system, it can be thoroughly tested by working the compressor and permitting air to enter at the suction through the special valves provided for that purpose and it should be perfectly tight at 200 or 250 pounds pressure per square inch and should be able to hold that pressure without loss. While testing the system under air pressure, it should be carefully and thoroughly cleaned of all dirt and moisture by blowing out.

In some cases it is impossible to eject all air from the plant by means of the compressor, therefore it is advisable to insert the requisite charge of ammonia gradually. In some cases from 60 to 70 per cent. of the full charge is put in and the air remaining in the system is allowed to escape through the purging cocks with as little loss of gas as possible, subsequently inserting an additional quantity of ammonia once or twice a day until all the air has been displaced and the complete charge has been introduced.

To charge the machine, the drum of anhydrous ammonia is connected through a suitable pipe to the charging valve. The machine should be run at a slow speed when sucking the ammonia from the tank with the discharge and suction valves wide open. When one of the tanks is emptied, the charging valve is closed and another tank placed in position, and the process continued until the machine is sufficiently charged for work, when the charging valve can be closed and the main expansion valve opened and regulated. A glass gauge upon the liquid receiver will show when the latter is partially filled and the pressure gauges and the gradual cooling of the brine in the refrigerator and the expansion pipe being covered with frost, will indicate when a sufficient amount to start working has been inserted.

The machine having been started and the regulating valve opened, the temperature of the delivery pipe should be carefully noted and if it shows a tendency to heat, then the said regulating valve must be opened wider, while if it should become cold, the valve must be slightly closed, the regulation or adjustment thereof being continued until the normal temperature of the pipe is the same as the cooling water which leaves the condenser. If the charge of ammonia is insufficient, the de-

livery pipe will become heated even when the regulating valve is wide open.

Among the signs which denote the healthy working of the plant, besides the fact that it is satisfactorily performing its proper refrigerating duty, are the vibration of the pointers of the pressure and vacuum which clearly mark every stroke of the piston, the frost on the exterior of the ammonia pipes, the liquid ammonia can be distinctly heard passing through the regulating valve in a continuous stream and the difference in temperatures between the condenser and cooling water and the refrigerator and the brine.

—o—

Some Characteristics of Electric Motors.

Modern electric motors may be divided into two general classes: those operated by direct current and those operated by alternating current. Direct-current motors may be subdivided into classes: shunt wound for approximately constant speed and series wound for variable speed. There are, however, numerous combinations of the two types of field windings, forming a third class known as compound wound motors.

Alternating-current motors may be divided into two general classes: the induction motor and the synchronous motor. In operation, the induction motor operates similarly to the constant potential direct-current shunt motor; that is, if the strength of the rotating field were maintained constant, the slip, the rotor electro-motive force and the rotor current would vary with the load. The rotating field does not, however, remain constant under varying loads. As the load increases, more and more of the field flux becomes useless for turning the rotor and the slip becomes greater and greater as the load increases. The speed of an induction motor is varied by altering the voltage, by altering the resistance of the rotor circuit or by commutating the stator winding so as to alter the multipolarity.

Any excited single-phase or polyphase alternator, if brought up to speed, and if connected to an electro-motive force of the same frequency and approximately the same voltage will operate as a motor. The speed of the motor in revolutions per second will be the quotient of the frequency by the number of pairs of poles. This speed is called the synchronous speed and the motor when it has attained that speed is said to be running in synchronism. This exact speed will be maintained throughout wide ranges of load up to several times full load capacity. Whether the synchronous motor is single, two- or three-phase, it has the same general characteristics, the number of phases being taken care of in the design of the motor.

Coming back to the direct-current motor, it was said that shunt-wound motors should be used, for where an approximate constant speed and variable torque are required and the series wound motor where the speed and torque are both variable. The compound wound motor is a combination of the shunt and series machine. Its most important use is where a very heavy starting torque is required and where occasional heavy loads must be carried, such as for motors connected to punches, shears or bending rolls. In these cases it is customary to give the motor just enough shunt winding to prevent its attaining a dangerous speed when the load is thrown off. In some cases a controller is furnished with compound-wound motors, which varies the number of series turns on the field. A motor with this regulation should only be used when the speed does not matter or where the torque required remains constant.

For driving a pump, a compound motor possesses the desirable feature of giving a strong starting torque with the least starting current, especially in cases where the momentum of a large body of water must be overcome. For traction purposes, the method of attaining speed control is accomplished by what is known as the series-parallel system. For slow speeds the motors are connected in series and for the higher speeds in parallel, series motors being used.

A motor which sprung into very wide use during the past ten years is the induction motor. The two attractive features of this type of motor are its simplicity and its ease of starting. The two methods usually employed for starting polyphase motors are by means of a low initial voltage or a variable resistance in the secondary. Motors having a fixed resistance in the secondary winding are started by applying to their terminals an electro-motive force lower than normal, which is secured from two small transformers. As the motor comes up to speed the switch is thrown over, connecting the motor on the full potential for which it was designed. In motors with a variable resistance in the secondary, the full potential is thrown on the primary but a resistance is inserted in the secondary winding which is cut out as the motor comes up to speed.

Synchronous motors do not have sufficient torque at starting to satisfactorily come up to speed under load. They are therefore usually brought up to synchronous speed by some auxiliary source of power. In case of polyphase systems, an induction motor is very satisfactory. Its capacity need be but one-tenth that of the large motor. Before connecting a synchronous motor to the mains it is necessary that the motor should not only be in synchronism but should have its electro-motive force at a difference of phase of about 180 degrees with the impressed electro-motive force. To determine both these points, a device known as a synchronizer is employed. It sometimes consists of an incandescent lamp connected in series with the secondaries of two transformers, whose primaries are connected respectively with the line and with the motor terminals. The brightness with which the lamp glows is a measure of the phase difference between the two electro-motive forces. It is customary to so connect the transformer that when the motor electro-motive force is at 180 degrees with the line electro-motive force, the lamp will have its greatest brilliancy. As the motor is coming up to speed, the lamp will be alternately bright and dark. The alternations will grow slower as synchronism is approached and will finally be slow enough to permit the closing of the main switch at the proper instant.

Owing to their different starting characteristics, the induction and synchronous motors are used under different conditions. The induction motor, on account of the greater ease with which it starts, is used where the motor is required to stop and start frequently. The synchronous motor, on the other hand, is used where the motor after having once been started can be left running, its power being applied by clutches or by the regular system of line shafting.

—o—

To remove a rusted screw, heat the top by applying a red hot piece of iron and apply the screw driver at once.

—o—

An old Turkish towel cut in strips is better than cotton waste for cleaning brass work.

The
Practical Engineer

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Low Priced Fuels. In many parts of the eastern portion of this country, there is a decided tendency, especially in large cities where the smoke ordinance is in force, to make use of the lower priced small sized anthracite fuels. In some plants, these smaller sizes have taken the place of the more expensive large size anthracite coal; in others, it has replaced bituminous, while in others a mixture of a small per cent. of bituminous with a larger per cent. of small sized anthracite is used.

In all of these plants where the cheaper grades of fuel are used, some device is usually necessary, such as steam jets or blowers, in order to obtain the rated horse power of the boiler under which it is used, but with the result that in many cases there is a marked saving in the coal bill.

There is still one grade of fuel that remains to be burned successfully and economically, and that is culm. Thousands of tons of this coal dirt are piled up near every anthracite mine and the problem has not yet been solved how to extract commercially the heat units which are available in it.

Culm is now being burned successfully, however, upon plain grates for hot water, and low-pressure steam heating systems and in hot air furnaces without any preparation, so that the time seems not far distant when it will be used for power purposes in the same manner that rice and bird's-eye sizes of anthracite are now used, it being not so many years ago when these sizes were also thought to be worthless.

—o—

$C = E \div R$. In looking over the many books written upon the subject of electricity, it will be found that there seems to be a confusion among them as to the way in which Ohm's law is stated. Some of them give the law, which gives the relationship of current, electro-motive force and resistance in any circuit, as $I = E \div R$, while others give it $C = E \div R$.

To go back to the earlier days of the electrical science, one of the first and most valuable rules known to the practical man was Ohm's law, and since this law states that the current flowing in an electrical circuit is equal to the electro-motive force divided by the resistance, naturally the first letter of each of the words current, electro-motive force and resistance were taken as symbols. In fact, so universally was this adopted that the American Society of Electrical Engineers used it as symbolic of their society and all the buttons worn by the members contained the equation, $C = E \div R$.

About ten years ago, some of the big guns in the electrical industry were not satisfied with the letters used to designate the various electrical units, so that a new code was adopted and the symbol C for current was changed to I because I designated intensity of current. The letter K, which had been used for the unit of capacity, was changed to C. The result of this change was and has been ever since to cause confusion

among electrical students and workers. It was just the same as if some other body of men had come along and upset the well-known horse power formula.

The position which most engineers take to this Ohm's law confusion is very similar to the man who comes to this country from a foreign shore. He may speak, read and write the new language but he always thinks in his mother-tongue. An engineer in charge of a large electrical system recently said that he always uses, and so do most of his men, the symbol C when using Ohm's law for making calculations of electrical circuits, notwithstanding that in discussions or when writing they use the symbol I.

The writers of the many electrical books are beginning to realize that the sentiment of the workers in the electrical industry is toward the Ohm's law formula in its original form. Since there are very few stationary engineers who are not in some way connected with the electrical industry, the difference in nomenclature of the electrical units throughout many reference books is very apt to be confusing to them also.

So long as E stand for electro-motive force and R stands for resistance, so long should C stand for current. To the practical man, at least, the formula $C = E \div R$ seems like the only rational one to use.

Practical Examination Questions.

The word "education" is almost always associated with the thought that it necessarily means "book knowledge." When the word is applied to the engineering profession, it is generally taken for granted that an educated engineer is necessarily a book engineer. This is altogether a wrong impression. "To prepare us for a living is the function which education has to discharge," says Spencer, and so long as a man is gaining knowledge he is gaining education, no matter whether he gets his information from books or in the hard world of experience.

Of course, there are all kinds of education but the education which an engineer must have pertains principally to the laws of nature. This is the practical education that informs one that if the inexorable laws of nature are infringed upon, dire results must be expected. Among these laws of nature which should be more or less known to the practical man are the laws of physics, of which electricity is a part, engineering, chemistry, applied mechanics and the like.

What is necessary to be known in the engineering field is often overlooked by the framers of engineers' examinations and many a man who is perfectly able to run a steam plant is asked questions which are of no more use in his profession than the dead languages.

Let the examiners catch up with the idea that an examination should reveal the practical knowledge that a man possesses and not make their examinations something to be dreaded by the practical man.

Increased Use of Mechanical Refrigeration.

It has not been so many years ago when cold storage as applied to food products was obtained entirely by the use of ice, but today there are many millions of dollars invested for the purpose of producing artificial refrigeration.

The growth of this industry can be attributed principally to the fact that by its means, any desired degree of temperature can be attained and maintained, the tendency of the times being toward lower and lower temperatures until a temperature of zero and below is not now uncommon.

Naturally, one of the principal reasons of this large growth has been the demand for the storage of perishable food products, such as fresh fruit, eggs, butter, cheese and meats. Certain kinds of food products, such as poultry and meats, are improved by cold storage but fresh fruits are not generally improved although, of course, it does not prevent their use for food. Eggs and butter have been kept a year or more without, it is said, any appreciable change in the quality of the goods.

There are many other uses, however, that mechanical refrigeration is being used for. One of these which has become very lucrative within the past few years has been the keeping of furs and fabrics in cold storage. It has been found that at a temperature below 50 degrees, the moth and beetle which are ordinarily so destructive in warm weather, are killed, so that cold storage is a sure preventative of destruction to all kinds of furs and fabrics. Since many fur garments are valued in the thousands of dollars and many tapestries in the tens of thousands, it can easily be seen why cold storage is a favorite method of keeping them in the warmer months.

There are also many other uses for cold storage, such as the keeping of cut flowers, fruit trees for planting and even the storage of candles in summer, but if the preliminary experiments are borne out, one of the most humane services cold storage has yet performed is the curing of people affected with hay fever. It is said that persons who otherwise would have to select colder climates in summer can by entering a cold storage room for several hours be entirely cured of their hay fever.

Considering that mechanical refrigeration is still in its infancy and that the effect of humidity and temperature upon various articles is still unknown, the manufacture of cold has made wonderful strides in the past and is bound to come into still more universal use in the future, as this knowledge increases.

To clean brass, mix 1 oz. of oxalic acid, 6 oz. of rottenstone, both in powder, 1 oz. sweet oil and enough water to make a paste. Apply a small portion and rub dry with flannel or soft leather.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

An Oiling Device for Loose Pulleys.

EDITOR THE PRACTICAL ENGINEER:

In your January number I notice an article by A. E. Rhodes, describing a home-made loose pulley oiler. Now, in the plant where I am employed, we make use of a device that I have never seen elsewhere. In small pulleys, say up to 10 or 12 inches, we drill a ¼-inch hole down through the centre of one of the spokes into the bore and tap for a $^5/_{16}$-inch blind set screw. By being careful when tapping, the screw can be made so that its head will be $^1/_{64}$-inch below the face of the pulley.

We find this device very convenient in places where it is impossible to get at a hole in the hub. The screw protects the belt from oil and by shifting the belt onto the tight pulley, the oil hole can be easily reached. With large pulleys we do not drill through the spoke but drill through the face between the spokes a hole large enough to admit a ¼-inch pipe. This pipe is also tapped into the hub and screwed in tight, after which it is cut off near the face, riveted down and filed off flush with the face. The pipe is then tapped and supplied with a set screw the same as in a small pulley.

Solon, Ohio. F. D.

Storage Batteries.

EDITOR THE PRACTICAL ENGINEER:

Enclosed find a few remarks on storage batteries, and their use in a certain power house where I am employed.

Storage batteries used in railroad work are known to float on the line; that is to say, when the batteries are in the circuit, they charge or discharge according to the line voltage. In power houses or central stations where high-tension current is employed, arrangements are made so that when the high-tension voltage reaches a certain point, the batteries either charge, discharge or remain neutral.

In one particular power house, with which I am acquainted, when the high-tension voltage reaches 6400 volts, the batteries are neutral (neither charging nor discharging). When the high-tension voltage reaches 6500 volts, then the batteries begin to charge and when the voltage is 6300, the batteries begin to discharge.

The question now arises, what connection is there between the high-tension voltage at the power house and the storage batteries in the sub-station? To consider this question we must first start in with the power house. The alternating current generators must run in synchronism and the rotary converters in the sub-station must also operate in synchronism with them. Now, suppose that when a load comes on, the engine tends to slow up. This will affect the rotary converters in the sub-station, because any change of speed will affect the phase of the generators, and therefore to keep in synchronism the rotaries must slow up. Considering the direct current side of the rotaries, if the machine slows up, the voltage will drop, because the voltage depends upon the number of revolutions and the number of turns of wire on the armature and the strength of the field. The storage batteries will therefore begin to discharge.

By this system all the trouble of end cells and differential wound boosters is eliminated, making it a very desirable one. This system is used by the Metropolitan Street Railway Co., of New York. A person watching the ammeter on the storage battery switchboard will notice the needle swing back and forth, showing that the batteries charge and discharge. When the storage batteries on the line are charging and discharging they are charged by a shunt wound booster. In the sub-stations the batteries are charged in sections.

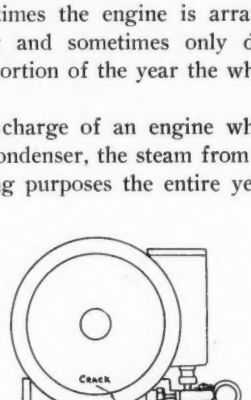
New York, N. Y. J. G.

Repair to Cylinder of Half-Condensing Engine. How to Set Valves.

EDITOR THE PRACTICAL ENGINEER:

In New England it is frequently the case that engines are run half-condensing; that is: one end of the cylinder runs on the condenser and the other end runs non-condensing, the steam from this latter end being used for heating the feed water, mill heating, and boiling, so that a considerable saving is effected. Sometimes the engine is arranged to run continuously this way and sometimes only during the winter months, the other portion of the year the whole cylinder being run condensing.

Recently I took charge of an engine where the head end ran on a Buckley condenser, the steam from the crank end being used for heating purposes the entire year. As 18 inches

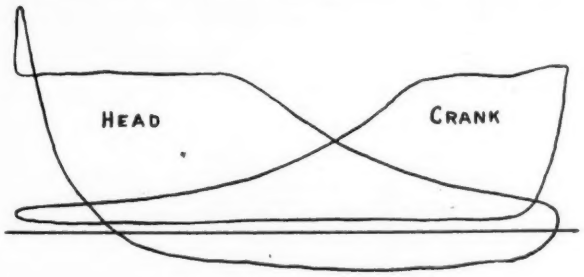


Repair to Cracked Cylinder Casting

vacuum was all I could get, it was necessary to run the priming pump continuously, notwithstanding the fact that the condenser was set at such a height that it should draft its own water. An investigation was therefore begun. It developed that in the past, the cylinder had received a dose of water which not only broke the crosshead and knocked out the cylinder head but it cracked the cylinder casting, as shown in sketch, which explained one reason for the poor vacuum. I removed the cylinder head and found the depth of crack to be about 1½-inches deep, 2½-inches long and $^1/_{16}$-inch wide.

I carefully cleaned all oil and other matter from crack and

made a rust joint composed of sal-ammoniac, sulphur and iron filings, which I mixed to a stiff paste and applied with a knife, crowding the crack full. A piece of iron ⅛-inch thick was obtained and drilled and tapped for ¼-inch cap screws. The cylinder head was replaced, leaving the packing extended. The iron plate was then held to the cylinder, the holds made to correspond and was screwed to casting with cap screws. The joint is entirely tight and 4½-inches vacuum was gained. It is to be understood that to run one end condensing while the



Valve Adjustment as Found

other end is run high pressure, it is necessary to have a separation in the exhaust chest or an exhaust pipe at each end is required.

Enclosed is a tracing of a card taken from the engine on my arrival. It is well known that when the indicator pencil traces the lines of admission and expansion, release and compression are taking place at the other end of the cylinder at the same time; that is, the opposite back pressure line and compression belong to the other end, so to speak.

Now, the vacuum in a case like the one under consideration is a benefit to the end it is not in, so that the crank end has a much lower back pressure to work against than the head end. Now, if valves are set for equal cut-off, the crank end will do the most work; therefore, to balance the load it is necessary to reconstruct the diagram by transferring the back pressure line from one end to the other and when the areas of both diagrams are equal, after this reconstruction, the effect is balanced and is brought about by lengthening the head end cut-off, which has the atmosphere to work against and whatever pressure may be caused by the piping to the heater.

Lawrence, Mass. A. W. B. E.

By-Passes and Short Cuts.

EDITOR THE PRACTICAL ENGINEER:

The study of mathematics and the solving of difficult problems are excellent practice for the engineer when he has plenty of leisure, but there are occasions when a by-pass or short cut will arrive at the same result much sooner and quite as accurately.

For instance, in the January number of THE PRACTICAL ENGINEER, a simple question was given and answered by Chas. J. Mason and covered a whole column of the paper. The question was practically this: Given an engine running at 70 revolutions belted to a 4-foot jack pulley and developing 264 horse power, required the number of revolutions of the engine and the diameter of the jack pulley needed to increase the horse power from 264 to 330 without changing the pressure or speed of the jack shaft.

In this problem, neither the fly-wheel diameter, cylinder dimensions, boiler pressure nor mean effective pressure cut any ice and are negligible quantities and all we need for a short cut is to take the ancient "Rule of Three" and multiply 70 by 330 and divide by 264 for the required velocity; then multiply 4 by 330 and divide by 264 and the required diameter of the new jack pulley is obtained. The same process will give the diameter of the new governor pulley. It will be seen below that the results are the same as Mr. Mason's longer process.

$$\frac{70 \times 330}{264} = 87.5 \text{ revolutions,}$$

$$\text{and } \frac{4 \times 330}{264} = 5 \text{ feet in diameter.}$$

The reason why this rule fits in here so easily is because in the regular power formula A P V ÷ 33,000 = H. P. A, the piston area is a constant, but P, the mean effective pressure, and V, the velocity of the piston, are variable quantities, so that any increase or decrease in either one of them will cause a *pro rata* increase or decrease in the amount of power developed.

Bridgeport, Conn. A. H.

Peculiar Explosion of a Solid Piston.

EDITOR THE PRACTICAL ENGINEER:

Perhaps it will be of interest to some of the readers to hear about a very peculiar explosion that took place at the plant where I am employed as engineer. The plant is a fairly large one and they have their own machine shops. A short time ago, a piston rod in one of the smaller pumps broke off flush with the crosshead. After removing piston and rod from pump, it was taken into the shop for repairs.

The piston was of the solid type, having two expansion rings 10⅛ inches in diameter. The rod was 2 x 42 inches. The rod had been put into the piston by hydraulic pressure and then peened over. After a dozen unsuccessful attempts to remove the rod, it was suggested that the piston be placed in the forge and heated. One man was instructed to hold one end of the rod while the other end was being heated.

Suddenly there was a terrific explosion; the piston was blown into a hundred fragments, the fire and ashes were blown all over the room, the walls of the building were shaken and the entire shop was more or less damaged. The man that held the piston rod had his arm blown off and a piece of steel struck him in the side with the result that he will die. Another man is expected to lose both his eyes, while several others were slightly injured. I would like to hear from some of the older engineers as to what caused this peculiar explosion.

St. Joseph, Mo. A. D.

Banking Fires.

EDITOR THE PRACTICAL ENGINEER:

I would like to give expression to my views on banking fires. I want to do so after having read what C. D., of Prescott, Wis., says in the February issue. In the first place, I beg to differ with him in many respects. I have had experience in marine work where I believe boilers are subjected to about as rough usage as most boilers get and there is comparatively little trouble with leaking tubes. Tug-boats, which are often compelled to stop suddenly, then lie still for some time and then

start suddenly upon receiving orders to proceed, are very often compelled to accomplish their work with forced fires which have in the meantime become dead.

It is a rule in these cases to bank fires with closed dampers and open furnace doors. The doors are fastened opened at that, because it is a rule laid down by the U. S. Local Steamboat Inspectors, of New York Harbor District, for if doors are not fastened, they are apt to become closed when the boat rolls, and up will go the steam even with the dampers closed.

I have fired all kinds and types of marine boilers and laid them up for the night and I have served under old as well as young modern engineers, good men, too, and my instructions have always been to compel firemen to fasten doors open, close dampers and bank fires after having filled the boiler properly with water, which agrees with the editor's instructions. While using this method, nobody ever had cause for spending their Sundays in hot combustion chambers, repairing leaking tubes. I am now serving as an engineer in an electric plant and have seen more leaky tubes, more tubes blow out and more boiler troubles in general during a space of three months than I ever saw in three years with the above-mentioned marine boilers—abused, if Mr. C. D. will have it so.

West Hoboken, N. J. P. J.

Defects and Repair of Cheek Blocks.

EDITOR THE PRACTICAL ENGINEER:

During my experience as a general repair man, I have run across several defects in bearings; on several occasions I have found defects in the cheek blocks. Quite recently I had an experience of this kind on a 250 horse power engine. The shaft was 12 inches in diameter and had a main bearing 22 inches long. This bearing was composed of four pieces, top and bottom pieces and two cheek blocks, adjusted by wedges. One of the cheek blocks was broken clear through where it had come into contact with the wedge. These wedges were

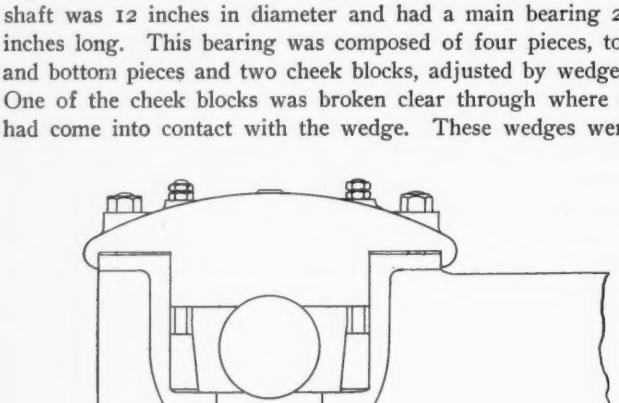


Fig. 1

connected to a long bolt or rod that entered up through the cap with a nut and lock nut on the top, as shown in Fig. 1.

When the cheek blocks are new or when the bearing is newly Babbitted, the cheek blocks fit back to the bed, but as the wear is taken up by the wedges, the quarter box is carried away from the bed and depends for its bearing upon the wedges alone. This bearing is inadequate for the strain and owing to the vibration of the shaft, it is impossible to keep it entirely rigid, so that in time, owing to the continual jar, a crack is liable to occur on a line across the quarter where the wedge bears.

There is another kind of bearing which is constructed on similar lines with the exception that the screws for adjustment are carried from the front end of the bed to the back of the cheek block, as shown in Fig. 2. With this arrangement, the cheek block against which the screws bear are the ones that usually break. It is very seldom that the other blocks go, as they are bearing against the bed while the strain of the screws due to uneven adjustment and the vibration cause the blocks against which the screws bear to give away.

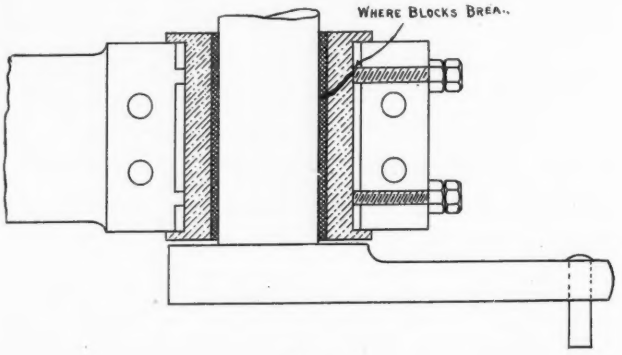


Fig. 2

On one occasion, I repaired one engine by making a new cast-iron quarter box and Babbitting it in place on the shaft. Before pouring, we inserted a steel back plate to equalize the strain on the screws. On another engine where the adjustment was made by the wedge method but it was not possible to use a back plate, we made a quarter box out of machinery steel, Babbitting it and scraping out. Usually these cheek blocks break at a point across the inside wedge or screw, as there is more strain there. When the outside wedge or screw is left looser than the inside one, it has a leverage, as shown in Fig. 2, which is sure to break the quarter at the inside screw. I have never seen one broken at the wedge or screw on the crank side of the bearing as when that end is the tightest, it steadies the shaft and does away with the strain.

Lost motion in quarter boxes can best be taken up, if possible, when the engine is running, as owing to the thrust and pull of the crank, the lost motion can be detected very easily. They should be taken up gradually, first one screw and then the other. Some engineers tighten up on one screw till it is tight and then tighten up the other. If it happens to be the inside screw that is adjusted first, this may account for broken cheeks in some cases. Some engines are only adjustable by screws on one side of the bearing or on one cheek block, so the other block is necessarily adjusted by means of shims or packing, for if the front quarter is taken up right along and nothing is done to the back quarter, the crank shaft will be very gradually but surely crowded out of line. A good rule is to take a pair of calipers and take the distance from the shaft to the square that is planed off for the back quarter to bear against when the engine or bearing is new. Take this measurement at each end of the box; if the shaft is being crowded out of line, it can easily be detected and should be

adjusted and blocked up accordingly and then the front quarter brought up to the shaft.

By following these methods a very nicely running bearing can be obtained. Care should be taken not to screw up too tight; how much can best be determined by the operator, but always remember that a bearing had better be heard than smelled.

Bridgeport, Conn. C. H. T.

Why New Jersey Should Have a License Law.

EDITOR THE PRACTICAL ENGINEER:

New Jersey is badly in need of a license law, because in many plants the engineers and firemen hold their positions because of political ability rather than engineering ability. For instance, in the plant where I work, the superintendent is a plumber, only 23 years old, who was appointed by the Mayor and Councilmen, as were also most of the other employees around the plant. If there was a license law, there would be much better care taken of their boilers and the wonder is there are not more accidents.

In the power house where I am working, not a hundred miles from Philadelphia, there are two 100 horse power boilers carrying between 115 and 120 pounds pressure, safety valves set at 125 pounds. There are two shifts of 12 hours, an engineer and fireman on each shift. With the work required there should not be any excuse to put the boilers under unusual strain, but the way the steam is allowed to vary is little short of a crime.

On one day, the recording gauge showed that the steam pressure went down to 82 pounds, with only about half load on the engine, and in a short time the pressure was run up to 120 pounds. That something never happens in such plants is due to proverbial good luck. A few hours later, the steam dropped to 90 pounds and was again rushed up to 120 pounds within a short time. Any superintendent or chief would not under ordinary conditions stand for such things a minute but being under political influence, the superintendent never says anything to his men, on account of the pull they have got.

The people of New Jersey are not acquainted with these things and many others much worse, which endanger life and property, because if they were, they would have a license law before this. It is a shame that such careless men are allowed to handle boilers and engines!

N. J.

Raising Steel Stacks.

EDITOR THE PRACTICAL ENGINEER:

I see in the February number, that C. D., of Prescott, Wis., wants methods of raising steel stacks. Deeming diagrams unnecessary, I will give the methods which I have used when raising a stack 48 inches by 80 feet.

We first raised what we called a Jim-pole by splicing together 8″ x 8″ timbers to a height of 48 feet, the same being well guyed and set close to the brick foundation, which was 10 feet high. Then with the use of ropes and blocks we took a hitch on the stack at a point so that the lower end would hang down and we then raised the stack in place. Another method we used for raising a stack 30 inches by 60 feet was to raise two poles one on each side of the smoke box, then lash them together at the top so as to receive the tackle block. In both cases it is necessary to have guy wires on the stack so that it can be guided either way.

Clinton, Iowa. L. A. H.

Raising Steel Stacks.

EDITOR THE PRACTICAL ENGINEER:

I notice in your February number that C. D., of Prescott, Wis., wants information about raising steel stacks. I will give him my experience with a stack 30 inches in diameter and 45 feet high, which I made and erected myself. Fig. 1 shows the kind of derrick that I used. Fig. 2 shows the position of derrick in front of boiler with rope connected to stack.

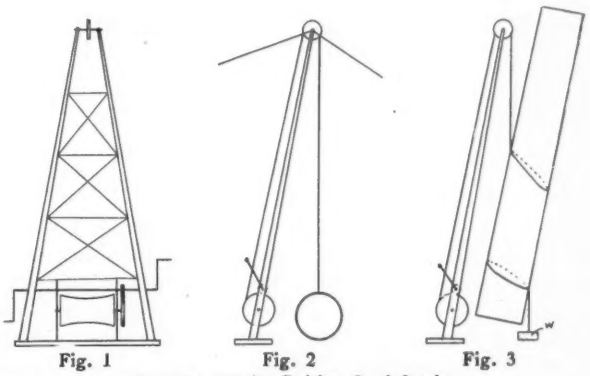


Fig. 1 Fig. 2 Fig. 3

Arrangement for Raising Steel Stacks

Before raising, fasten the guide wires and also chain a weight to the bottom end of stack so as to hold it in an upright position, as shown in Fig. 3. When you have it at the proper height, the guide ropes can be loosened to bring it over the smoke box. One thing must be remembered and that is that the distance from the bottom of the stack to where the derrick rope is fastened must be less than it is from the setting of stack to the top pulley of the derrick. I raised a stack by this method in a very short time.

Brookville, O. L. A. H.

Increased Chimney Temperature Probably Causes Reduced Boiler Pressure.

EDITOR THE PRACTICAL ENGINEER:

The communication from I. F. W., of Marion, O., in the January number of THE PRACTICAL ENGINEER, regarding the drop in boiler pressure, seems at first glance to be impossible but being a fact, there must be a cause. As no details are given, the best man can do is to speculate and the only place I can think to look for trouble is in the chimney. The temperature of the gases when carrying 140 pounds boiler pressure is considerably higher than when carrying 90 pounds pressure, especially if the boilers are not clean or are forced beyond their rated capacity. The higher the temperature of the gases, the greater their velocity and the less weight per unit of volume. Increase in velocity due to temperature does not compensate under all conditions for the corresponding increase in volume due to this rise in temperature and I presume that this is the condition with I. F. W.'s boilers.

The increased volume of gases, therefore, overtax the chimney and not enough air being admitted, the carbon in the coal is burned to CO, still further increasing the volume of

gases. If this be the case, forced draught will remedy it or the chimney must be increased in height.

There are a great many ways for finding the increased height of chimney but a simple one and one which would be on the safe side would be to consider the volume of gases at 90 and 140 pounds boiler pressure and assume that the capacity of the chimney is proportional to the square root of the height and area of the chimney.

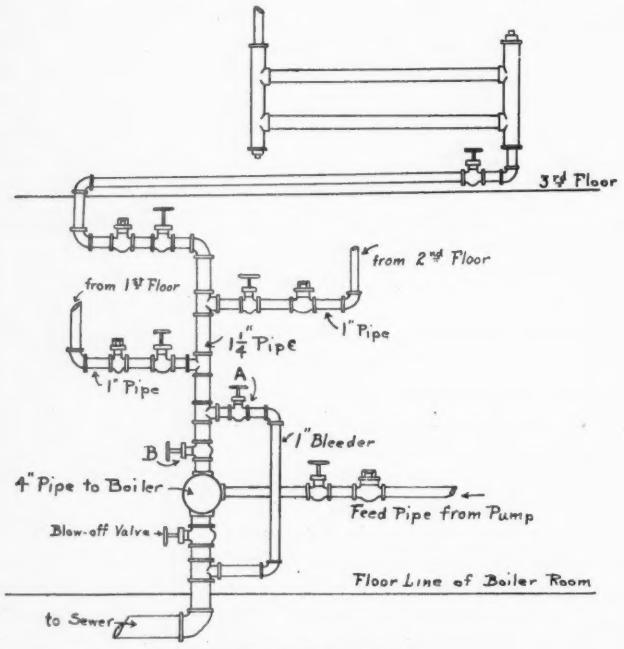
For example, take the height as 100 feet, temperature of the flue gases as 400 degrees or 861 degrees absolute, boiler pressure 90 pounds gauge and assume that is desired to carry 140 pounds pressure with the chimney gases at 450 degrees or 911 absolute. To find the height which would take care of the increase in volume, first find the increase volume, or $1 \times (911 \div 861) = 1.058$ or, say 1.06. Then the height $= (\sqrt{h \times 1.06})^2 = (\sqrt{100 \times 1.06})^2 = (10 \times 1.06)^2 = 10.6^2 = 112$ feet.

Chicago, Ill. H. M.

Returns for Heating System.

EDITOR THE PRACTICAL ENGINEER:

I notice in the January issue of THE PRACTICAL ENGINEER that H. H., of Beeton, Canada, is having trouble with returning the water of condensation to the boiler of his high-pressure heating system. I therefore thought it might be of interest to him and to other readers of this paper to show how I had the piping arranged for returning the water of condensation



Returns for Heating System

to the boiler room in a three-story building in which live steam was used for heating at high pressure.

The accompanying sketch shows the piping at the boiler and one of the coils on the third floor and also the return pipes from first and second floors. It will be seen that the water of condensation returns to the boiler through the blow-off pipe, through which the boiler is also fed by the pump.

The only trouble I had with this system was that the pipes would freeze during the night, as steam was turned off during the night, and some of the water of condensation would remain in the pipes where the steam was shut off at the boiler. To get rid of this trouble, I put in the 1-inch bleeder and shortly before shutting down time, I used to close the valve B and valve A wide and blow all the water, which would otherwise remain in the pipes, into the sewer; then the valves at the boiler were closed.

The check valves in this system were of the removable disc type, as I found that if any of these check valves leaked a little, the system would not work and for this reason the removable disc type was found best, because if one of them should become leaky, a new disc could be put in.

Milwaukee, Wis. H. J.

Cut-Off in Intermediate Cylinder.

EDITOR THE PRACTICAL ENGINEER:

In one of your answers to a question in a recent number of your paper, you say: "To decrease the load in the intermediate cylinder, make cut-off earlier in the intermediate and low-pressure cylinders." Now, I don't agree with you on that point.

Let it be assumed that the work done in the high- and low-pressure cylinders is the same and that the intermediate is doing more work than either and let us see what effect it will have by making cut-off earlier in the intermediate and low-pressure cylinders.

Increasing the back pressure in the high-pressure cylinder will increase the initial pressure in the intermediate cylinder. The effect of this is to reduce the work done in the high-pressure cylinder. Now, as the total power of the engine is to be the same as before, the power taken from the high-pressure cylinder must be taken up by the other two cylinders. We could make the terminal pressure less in the intermediate cylinder but to do that cut-off would have to be later in the low-pressure cylinder. Since the cut-off is to be earlier in the low-pressure cylinder it increases the back pressure of the intermediate and causes the initial pressure of the low-pressure cylinder to be higher. The only effect of the change has therefore been to decrease the power of high-pressure cylinder and shift it to the low-pressure cylinder.

If, however, we make cut-off later in the intermediate cylinder, the initial pressure will be reduced, thus reducing the back pressure of the high-pressure cylinder and the terminal pressure of the intermediate will be increased, which means a higher initial pressure for the low-pressure cylinder. The effect of making the cut-off later in the intermediate cylinder is to reduce the work done in that cylinder and to divide it between the other two.

Saginaw, Mich. E. E. H.

Quick Repair to Condenser Pump.

EDITOR THE PRACTICAL ENGINEER:

In handling engines with jet condensers, it sometimes happens that the condenser fails to work. In taking the condenser apart it may be found that either the suction or discharge valve of the pump, seat and all, are lying in the condensing compartment. This may be caused by the threads in the iron apron being eaten off with rust. As it is usually very expensive to have an idle condenser for any length of time, a quick and inexpensive repair to the pump is to make a crowfoot long

enough to cross the valve opening and strong enough to resist the pressure of pump; drill a hole in the centre, take nut off valve-stem that projects through seat, place seat in its original position, put crowfoot across bottom of seat with stem of valve through the drilled hole, replace nut and make tight. You will then have a valve seat in the pump that will stay there until the pump is worn out. I fixed a Worthington jet condenser of 800 horse power capacity that way and it worked all right.

Troy, N. Y. W. N.

Trouble with Elevator Thrust Bearing and Crank Pin Brasses. Remedy.

EDITOR THE PRACTICAL ENGINEER:

As I have often received valuable information in your paper, I send herewith a "kink" that helped me out of a serious difficulty and I give it in the hope that it may help someone else in a similar trouble. On taking charge in my present position, everything was new and among other things was a common belt driven worm gear elevator similar to Fig. 1, in which the winding drum is driven by a worm gear on a shaft which in turn is driven by either one of two belts, one belt being used to take the elevator up and the other to bring it down.

It will be seen by referring to Fig. 1, that the whole weight of the load of the elevator is taken up by the thrust bearing A. This thrust bearing was made with a brass cushion plate B

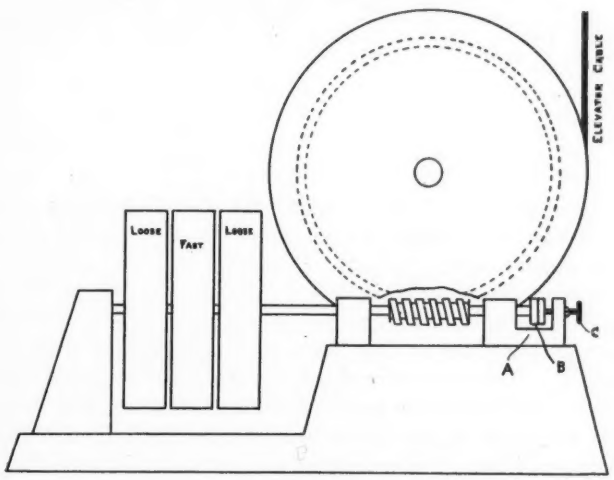


Fig. 1

bearing against the end of the shaft and a steel plate regulated by the set screw C, the intention being that the brass piece would reduce friction and when worn out could be quickly replaced.

For some reason this piece of brass would get hot and caused no end of trouble in spite of all the oil or grease I could put on it and would squeak so that it could be heard over all the building. We called in the builders of the machine and they tried different things, but made it no better, and the only way to keep the machine going was to take out the brass piece about four times a day and rub both sides with grease.

We kept it going that way for six months and then, one day, when it was particularly troublesome, I thought I would try something else. I took a piece of pine plank and bored a two and three-quarter inch hole in it with a Clark expansion bit and then nailed a smooth piece of board over the hole on one side. Then I turned the plank over and poured melted Babbitt metal into the hole to the depth of half an inch. That gave me a piece of Babbitt metal the same size as the brass piece that caused the trouble. I had no lathe to face it up, so I made it as smooth as I could with a file, then took out the piece of brass and put the piece of Babbitt metal in its place. I thought that the Babbitt metal would probably stop the squeaking but expected that it would be worn out in a few

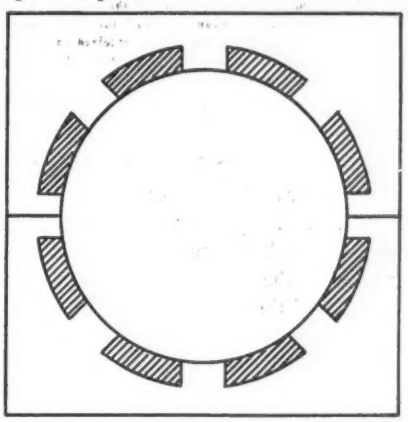


Fig. 2

weeks, but as it was easily made I was quite willing to make a new one whenever it should be necessary. That was over two years ago and the original piece of Babbitt metal is there yet and has never given a bit of trouble and has never had any attention except a few drops of oil once a day.

We also had considerable trouble with the crank pin brasses on the high-pressure side of our air compressor. It is a compound, single-acting, vertical machine with enclosed cranks that dip in the oil at every revolution. At the end of the stroke, the load on the high-pressure piston is about six thousand pounds and it is carried on a crank pin 1¾ inches by 2 inches. The brasses would get so hot after about three hours' run that we would have to stop. We tried everything we could thing of and had the builders of the machine come several times to help us out but we could not make it run more than half a day at a time. Then I took the brasses out and had them lined with Babbitt metal, as shown in Fig. 2, and we have never had any trouble with them since.

Montreal, Canada. F. A. L.

Why Do the Valves Stick?

EDITOR THE PRACTICAL ENGINEER:

I am in charge of a 10 x 24 engine having four valves. It is used for running a flange mill where there are all kinds of loads. When there is no load on the engine and the boiler pressure is 95 or 100 pounds, the valves stick and will not drop, but with all the load on, they operate all right. If I let the boiler pressure drop down to 65 pounds, the valves work fine with no load. I have tried everything I could think of to make the valves work right but with 100 pounds pressure they will not drop. I don't think it is for the want of oil. If any readers of THE PRACTICAL ENGINEER can help me out I would be glad to hear from them.

Exeter, Canada. N. L.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

In Reference to Plunger Packing.

EDITOR THE PRACTICAL ENGINEER:

In answer to J. S. P.'s question in the January issue, about pump packing, I would like to say that if he would get a new plunger fitted in the pump, allowing only $^1/_{32}$-inch clearance from the bore of the cylinder and if he will also see that the walls of the cylinder are all right and then pack with some good packing after the piston is trued up, the pump will work O. K.

Moultrie, Ga. N. S. W.

Effect of Lifting Brushes and Unequal Air-Gap.

EDITOR THE PRACTICAL ENGINEER:

1. What effect has the lifting of one or two sets of brushes on a six pole dynamo and motor, when running under a light load?

2. What effect has it on a dynamo or motor if one or more poles have a larger air gap than the rest?

New York, N. Y. I. H. K.

1. When a machine is in operation generating current, a brush should never be lifted from the commutator. If there are several brushes connected together, a single one may be lifted but it is better practice not to do so. If there is only one brush and it is lifted it will arc and probably burn the commutator.

2. If one or more poles of a dynamo have a larger air-gap than the rest, it will cause sparking at the brushes. Non-sparking machines demand an equal resistance to the magnetic circuit of each pole. This is impossible where there is an unequal depth of air-gap.—[Ed.]

Locomotive Questions.

EDITOR THE PRACTICAL ENGINEER:

Please give me some information about the Vauclain locomotive and what is the proper time and place to fill them with water?

Essen, Pa. A. G.

The principal features of the Vauclain compound engine consist in the arrangement of the cylinders. The engine of this type has one high-pressure and one low-pressure cylinder on each side, the ratio of volumes being about three to one. The two cylinders are cast in one piece, one above the other, together with the valve chamber and saddle. The valve employed to distribute steam is of the double hollow piston type, working in a cylindrical steam chest located in the saddle of the cylinder casting between the cylinders and the smoke box. The exhaust steam from the high-pressure cylinder becomes the supply steam for the low-pressure cylinder. In most other respects this type is the same as the ordinary single-cylinder engine.

The proper time and place to fill the boiler with water is when the locomotive is standing at a station or when it is running down grade. This will prevent the safety valve from blowing-off when the engine is using the least steam. When running on long level stretches, it is best to keep the injector running continuously so that the water level will remain constant.—[Ed.]

Generation of Electro-Motive Force.

EDITOR THE PRACTICAL ENGINEER:

Please answer the following question: In the accompanying diagram, Fig. 1 is the north pole of an electro-magnet, cylindrical in form and hollow. Fig. 2 is a ring armature showing one coil in winding, collector rings and exterior circuit.

If the armature was rotated near the magnet so that the conductors *a* to *b* would cut the lines of magnetic force, speed of armature and strength of magnet being constant, would an

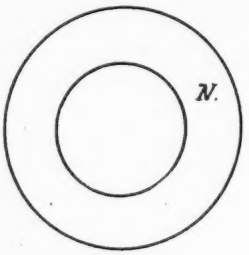


Fig. 1

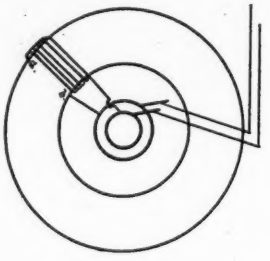


Fig. 2

electro-motive force be generated? In this arrangement each conductor in the winding is continually cutting lines of force at a constant rate.

Boston, Mass. O. H. W.

With the given arrangement, no electro-motive force could be generated because the fundamental principle of the generation of electro-motive force demands that in order that electro-motive force be produced in a wire, the rate with which the lines of force are cut by the wire must be variable, or the number of lines of force cut by the wire must be variable.—[Ed.]

Lost Motion for Pump Valves. Method of Adjustment.

EDITOR THE PRACTICAL ENGINEER:

Please let me know rule for lost motion in boiler feed pump valves. In a pump 6 x 8 x 10 inches, what lost motion would you give the steam valve with one-half port?

St. Louis, Mo. J. B.

The amount of lost motion necessary to the proper working of a pump cannot always be determined in advance but can best be determined experimentally. Small pumps, such as boiler feed and tank pumps, having a stroke of 10 inches and less, require a lost motion varying from ⅛-inch to ⅜-inch. The method of adjustment may be as follows: Place the steam pistons in the centre of the stroke and fasten the cross-heads to the piston rods midway of their stroke; the levers

should be connected to the rock shafts so that the rocker arms carrying the pins giving motion to the slide valves are in a vertical line, one rock shaft pin above the centre, and the other below it; the slide valves should now be placed on their valve seats and centred so as to cover the ports; the valve nuts should then be so adjusted that there will be an equal amount of lost motion on either side between the projections on the valve and the nuts by which it is driven. This adjustment must be made in both valves, after which the pump is ready for steam. It sometimes happens that one side of the pump needs an amount of lost motion greater than the other, but this must be found out after starting and can be quickly adjusted.—[Ed.]

Strength of Wrought Iron and Steel Plates and Rivets.

EDITOR THE PRACTICAL ENGINEER:

Kindly tell what is the tensile strength of iron and steel plates and also what is the shearing strength of different sized rivets.

Danbury, Conn. J. W. K.

The tensile strength of a wrought iron plate, such as is used for boilers, is about 45,000 pounds per square inch. Mild steel plates, such as are used in boilers, have an ultimate tensile strength of about 55,000 pounds per square inch.

The average shearing strength of wrought iron rivets may be taken as 34,200 pounds per square inch. Based upon this value, the following table has been computed:

SHEARING STRENGTH OF WROUGHT IRON RIVETS.

Diam. of Rivet.	Diam. of Hole.	Sin. Shear.	Doub. Shear.
5/8	11/16	12,695	24,120
11/16	3/4	15,110	28,709
3/4	13/16	17,733	33,693
13/16	7/8	20,564	39,072
7/8	15/16	23,608	44,855
15/16	1	26,861	51,036
1	1 1/16	30,322	57,612
1 1/16	1 1/8	33,995	64,591
1 1/8	1 3/16	37,877	71,966

The average shearing strength of steel rivets may be taken as 52,500 pounds per square inch. Based upon this value, the following table has been computed:

SHEARING STRENGTH OF MILD STEEL RIVETS.

Diam. of Rivet.	Diam. of Hole.	Sin. Shear.	Doub. Shear.
5/8	11/16	16,565	31,474
11/16	3/4	19,715	37,459
3/4	13/16	23,138	43,962
13/16	7/8	26,833	50,983
7/8	15/16	30,805	58,530
15/16	1	35,048	66,591
1	1 1/16	39,299	74,668
1 1/16	1 1/8	44,357	84,278
1 1/8	1 3/16	49,422	93,940

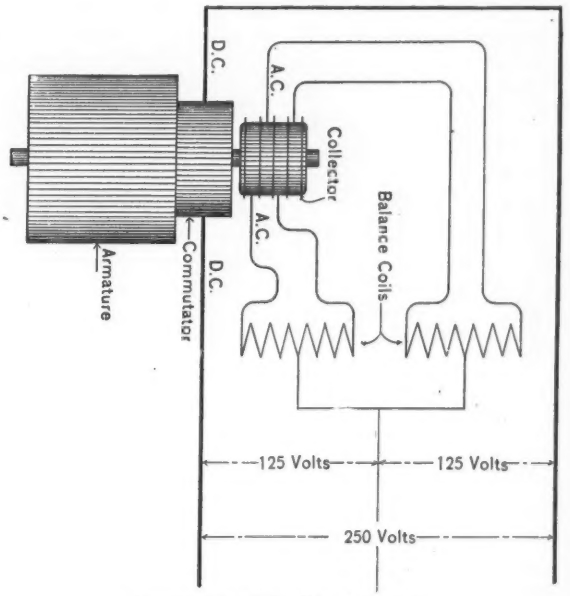
Generators for Three-Wire Direct-Current Service.

EDITOR THE PRACTICAL ENGINEER:

I want some information about the three-wire direct-current generator, as I expect to have one of these generators to look after shortly. Is the three-wire direct-current generator (the third wire being attached to the rear of the armature winding and furnishing the current for the neutral wire by means of a transformer) preferable to the two-wire generator with the balancing set for the three-wire system? Can any reader of THE PRACTICAL ENGINEER furnish me some information about their faults, such as sparking and transformer troubles, under wide variations of loads?

Minneapolis, Minn. R. H.

The three-wire direct-current generator has recently been introduced into the engineering field for the purpose of replacing the usual methods of operating three-wire systems. The usual method for operating three-wire is to use two generators and connect them in series, each generator being wound to supply the potential required by the lamps. The neutral wire is led from the brushes of the machines, which are connected together. Another method consists of two machines connected together as a motor-generator so that the machine on the lighter loaded side of the system operates as a motor and drives the other as a generator, thus developing the current necessary to provide the excess load and balance the system. This arrangement is known as a balancing set and gives good results, but the operation of the whole system depends upon the comparatively small balancing set.



Connections for 3-Wire Generator

The three-wire generator, as manufactured by the Westinghouse Co., is the same as the standard single voltage machine except that additional leads from the armature windings are connected to collector rings mounted on the armature shaft. The arrangement is exactly similar to that employed for the alternating current side of the armatures of rotary converters. This arrangement is of the two-phase type and across the two-phase collector a pair of auto-transformers or balance coils are connected, as shown in the accompanying diagram. These balance coils have a single winding about a laminated iron core of the shell type and are immersed in oil and mounted in cases similar to a transformer. The mid-points of the balancing coils are interconnected and from this connection is led the neutral of the three-wire system.

This type of generator is said to have its best applications in the distribution of electric light and power in office buildings

and for motor service which requires wide speed variation. We would be pleased to hear from any of our readers about their advantages or disadvantages of operation.—[Ed.]

Power Required by a Centrifugal Pump. Ratio of Expansion in a Compound Engine.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly answer the following questions for me in the columns of your valuable journal?

1. How is the required horse power of a centrifugal pump figured out; say, for example, the pump has a lift of 26 feet with a suction pipe 5 inches, discharge pipe 4 inches and is pumping against a head of 50 feet?

2. Will the pump lift water from a greater depth than a plunger pump?

3. Please explain the meaning of the total ratio of expansions in a compound engine.

San Francisco, Cal. C. H. Y.

1. The horse power required by the pump in question depends upon the speed at which it runs, which, of course, regulates the amount of water pumped. The economical discharge of a pump of the above size is about 500 gallons per minute, which is equivalent to 4165 pounds per minute. The total lift being 76 feet, the number of foot pounds required to raise that much water is 316,540 foot pounds. The horse power theoretically required is $316{,}540 \div 33{,}000 = 9.3$ horse power. Since the efficiency of a centrifugal is about 55 per cent. when working under the given conditions, the actual horse power is about 17 horse power. The velocity of the circumference of the pump under these conditions should be about 4800 feet per minute.

2. The plunger pump gives the best results for high lifts, since the efficiency of a centrifugal pump rapidly decreases as the lift increases.

3. In a compound engine, the only steam which should be used in the engine is that which comes from the boiler up to the point of cut-off in the high-pressure cylinder. After cut-off, this same steam is used to complete the stroke in the high-pressure cylinder and also to complete the whole stroke in the low-pressure cylinder. If, therefore, the volume of the low-pressure cylinder is four times larger than the volume of the high-pressure cylinder and steam is cut-off at $^1/_3$ stroke in the high-pressure cylinder, then there will be twelve expansions of the steam from its original volume.

A rule for finding the ratio of expansion is then as follows: Divide the volume of the low-pressure cylinder by the volume of the high-pressure up to the point of cut-off and the quotient will be the combined ratio of expansion. Another rule for finding the ratio of expansion if the initial and terminal pressures are known, is as follows: Divide the absolute initial pressure of the high-pressure cylinder by the absolute terminal pressure of the low-pressure cylinder and the quotient will be the actual combined ratio of expansion.—[Ed.]

An induction motor tends to produce a lag in the current supplied to it, so that circuits which contain many motors of this type have a comparatively low power factor.

Clinkers are said to be removed from firebrick by putting about a half-peck of oyster shells on top of a hot fire.

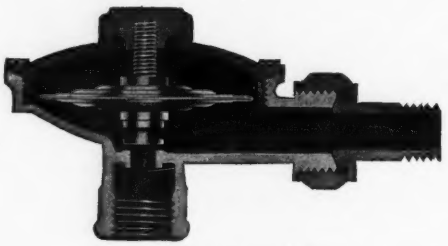
The Dunham Radiator Trap.

The illustration presented herewith represents the Dunham Radiator Trap, which is for use upon the return end of radiators, of vacuum or other systems where a difference in pressure is maintained between the radiator and the return pipes. The same motive force is utilized which operates all Dunham Traps made for either high or low pressure, differing only in the application, it being arranged to operate by conditions existing inside the radiator, rather than that of the return.

There are no floats or expansion plugs used in its construction. The combined disc and valve is securely anchored in direct line with a flat seat, which is ground in and forms a perfect joint when the trap closes.

The trap connects direct to the return end of the radiator by a nipple and ground union, and the discharge leads to the main return. The cap is carefully ground in, and is made perfectly tight without the use of gaskets. To this cap is secured the disc, which is adjusted to meet all conditions and is permanently set before leaving the factory.

The trap remains wide open when cold, and as there is no water seal, it cannot freeze. Air and water pass through it rapidly, but steam closes the valve the instant it comes into contact with the disc, holding back the steam until its heat units have been given up, and then opening again to permit the escape of condensation, thus formed. Oil and foreign matter usually found in most heating plants do not affect the action of the trap. It has no sliding contacts and friction is eliminated.



The Dunham Radiator Trap

These traps are made entirely of phosphor-bronze and are nickel-plated. They are made of angle or corner patterns, as desired. Further information will be given on application to the manufacturers, the C. A. Dunham Co., of Marshalltown, Iowa, or to L. Bancroft Mellor, 14 South Fourth Street, Philadelphia, who has exclusive sale of these traps for Philadelphia and surrounding territory.

Solid Packings vs. Self-Setting Packings.

A series of scientific tests were recently made by the Quaker City Rubber Co., of 409 Market Street, Philadelphia, to determine the relative life and amount of friction of solid and self-setting packings. Solid packings are those by means of which leaking is prevented by the packing swelling from moisture or heat, or by the screwing up of the gland to compress the packing to the rod, or both. In self-setting packing, the pressure on the rod is secured by means of the steam pressure on the packing, or both, forcing the cushion and wedge to the rod, the wedge being free to work backward and forward with the varying pressures in the cylinder.

The self-setting packing is placed in the stuffing box loosely,

the gland set up to it gently and secured by the gland bolt and nuts; then as the steam or fluid strikes the cushion, the packing adjusts itself to the rod with a degree of tightness barely sufficient to prevent leaking and in proportion to the varying pressures on the packing.

Self-Setting P. P. P. Packing

The scientific tests made by the Quaker City Rubber Co., between their "P. P. P." Packing, shown in the accompanying illustration, as representative of self-setting packings and solid packings are given by them as follows:

Solid packings, or those not self-setting, increased the friction on the rods so that it required from 2.31 to 7.27 more horse power to maintain the same piston travel than when self-setting "P. P. P." Packings were used, while the increased friction on the rod with the solid packings ranged from 11.62 to 59 per cent. These tests are also said to have shown a saving of from $104.96 to $250 a year per rod when self-setting packings were used, while their cost was from 80 to 240 per cent. less than solid packings.

The Mullan Vertical Wet Vacuum Pump.

One of the most important auxiliaries of the steam power plant is the so-called "air pump," upon the practical efficiency of which depends in large measure the total efficiency of the plant. Without an air pump capable of good performance under all varying conditions of load, the maintenance of a constant high vacuum in the condenser is impossible.

In the Mullan Suction Valveless Single Acting Crank and Fly Wheel Wet Vacuum Pump, shown in the illustration, Fig. 1, high efficiency is combined with simplicity of design, resulting in a machine which meets the most exacting requirements of modern power installations, such as large reciprocating engine and steam turbine units installed in electric railway power stations where the load is heavy and variable.

The old type of air pump is in reality a water pump, and as such is constructed with three sets of valves: foot, bucket and head valves. This design becomes inadequate under the more exacting requirements of constant high efficiency under widely varying load for the following reasons. The use of bucket valves means a relatively large clearance space above the bucket, causing loss of efficiency through evaporation of the water of condensation in the clearance space as the bucket descends. The foot valves cause further losses of efficiency as well as irregularity of operation by requiring all accumulation of absolute pressure in the condenser in order to overcome the inertia of the water and lift the valves, that is to say, by requiring a wasteful back pressure in the low-pressure engine cylinder or in the last stage of the turbine, as the case may be.

The higher the speed at which a pump of this type is driven, the greater the absolute pressure required to overcome these resistances, owing to the very short time available; so that higher speed means not only increasing back absolute pressure

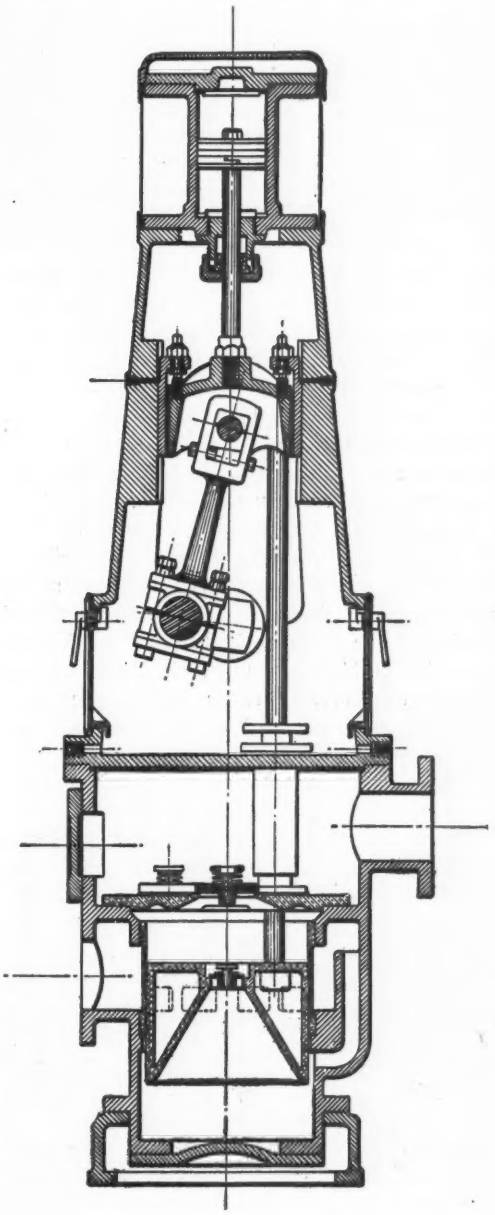


Fig. 1

and therefore reduced efficiency, but also increasing liability to violent shocks which often culminate in a breakdown of some portion of the pump or driving gear.

In the Mullan pump, as will be seen in reference to the cut, the water and air are dealt with mechanically, and foot and bucket valves are entirely dispensed with. Every lift of the bucket takes its due amount of the water, and increase of speed

does not impair the efficiency of the pump. The new pump has a single-acting water-packed bucket with a conical bottom having a central opening communicating with a small relief valve for taking care of any water which may be carried into the bottom of the cylinder by the grooves in water-packed bucket. The suction chamber delivers the condensation and its entrained

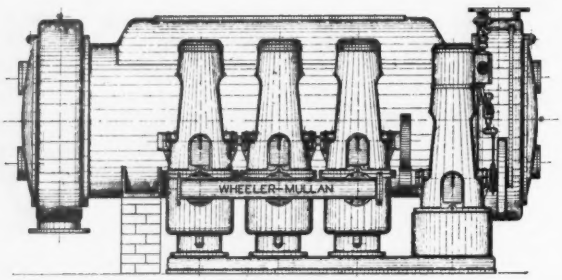


Fig. 2

air through openings in the inner shell of the cylinder, above the top of the bucket, instead of at the bottom, as in the usual type of pump; as the bucket rises the action is that of a "water hoist," rather than that of a pump in the ordinary sense of the word. The absence of foot valves to be lifted on the up stroke, or of bucket valves to be lifted on the down stroke, leaves the communication with the condenser perfectly free and open at all times, preventing the accumulation of back pressure. Moreover, it will be noted that by the construction all the air is ejected first, and that the clearance space at the top of the stroke is so small that nearly all the water, as well, is ejected, thus giving practically no opportunity for air entrained in the water and expanding during the down stroke of the bucket to accumulate in the space at the top of the cylinder.

In a word, the Mullan pump maintains a constant high vacuum in the condenser system by exerting a powerful, con-

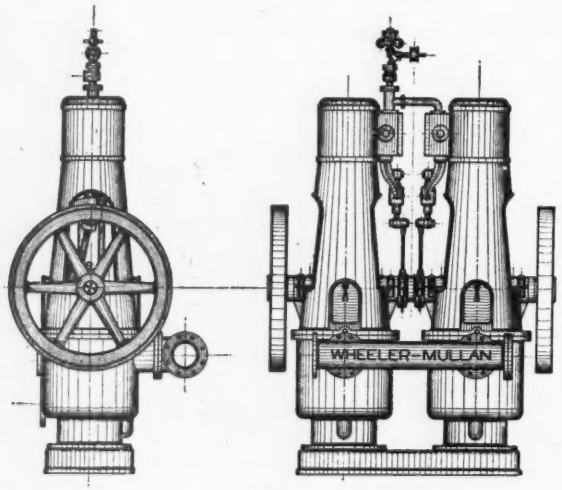


Fig. 3

tinuous and non-intermittent suction, and therefore constitutes an ideal auxiliary to the condensing steam engine. So perfect are its workings that it will operate under shop test conditions within one-half inch of the barometer, thus enabling the manufacturer to guarantee a vacuum within two inches absolute, under full load conditions of steam turbine operation. The simplicity of its design and the absence of foot and bucket valves reduce maintenance to a minimum, while its smooth operation and accessibility for adjustment or repairs render a breakdown practically impossible. It is sturdily built, of the best materials, and is furnished for steam, belt or gear drive, or on an extended bedplate for direct connection to an electric motor.

The C. H. Wheeler Improved Condenser, shown in combination with a Mullan Triplex Pump (see Fig. 2) was described on page 29 of our November number. Fig. 3 illustrates the Mullan duplex design.

For further particulars, address the C. H. Wheeler Manufacturing Co., Philadelphia, Pa.

The Stayman Piston Valve.

The ideal valve for a steam engine is one which is always evenly balanced so that there is no pressure on the seat due to the steam pressure. The piston valve fulfils these functions and as usually made, the valve chest is bushed, the bushing being

The Stayman Self-Expanding Piston Packing

accurately turned to form the valve seat and the valve is made tight by the use of piston rings. This type of valve is, therefore, on account of its simplicity, very much used on high-speed stationary engines, and marine engines.

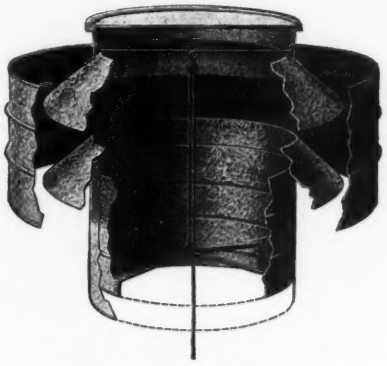
One of the difficulties encountered with the piston valve has been that if for any reason the valve seat wears out of round, the usual packing will not take up the irregularity. To overcome this, the Stayman self-expanding piston valve has been designed. The principal feature of this valve is the packing, shown in the accompanying illustration.

As will be noticed, the packing consists of four parts, the inner spring and the interlocking segments. The inner spring allows the expansion and contraction of the interlocking segments so that they automatically adapt themselves to variations in temperature and any unevenness in the valve chest. The interlocking segments are designed so that they will be steam tight. The packing and expansion rings are held in place on the barrel of the valve by means of a detachable head and corresponding flange. For further information as regards the construction and efficiency of operation, address the manufacturers, Stayman Manufacturing Co., 143 Liberty St., New York City.

The Burt Combination Skylight and Ventilator.

The ventilation of factories and engine rooms is a subject which has attracted much attention during the past few years, as it is now generally recognized that without the proper ventilation, it is impossible to attain the best result of one's labor either in quantity or quality. A dull, heavily laden atmosphere, combined with poor lighting, is conducive to poor health and lack of energy and it is therefore of importance, both for sanitary and financial reasons, that all such buildings should be given the best possible equipment for ventilation and lighting.

The Burt ventilator, shown in the accompanying illustration, is designed to answer the above requirements and removes impure air, hot air, smoke, steam or gas from any building automatically and without any expense other than the first cost of the ventilator. It is so constructed that even in calm weather, when ventilation is most needed, the impure air is drawn from the building. It prevents any back current of air and it is said that it never becomes clogged with snow, ice or other substances.



Sectional View of the Burt Glass Top Ventilator

One of the important features of the Burt ventilator is that it constitutes both a skylight and a ventilator. As shown in the illustration, the top is heavy wire-glass which is set in a groove and made water-tight by means of waterproof cement. Below the glass top is a trough into which runs any condensed water that may gather on the glass, whence the water passes through small holes to the outside of the ventilator. The ventilator is regulated by a patent damper which consists of a sliding sleeve which is operated from below by means of a cord and pulley. The sliding sleeve damper is so arranged that it does not collect dust or refuse, as it does not have any flat surface.

The ventilators are manufactured in all sizes, being built throughout of galvanized iron, riveted and braced. The ventilator is guaranteed against leaks and defective workmanship and material and will be replaced at any time if found defective. They are manufactured by the Burt Manufacturing Co., of Akron, Ohio, makers of the well-known oil filters and exhaust heads, who will be pleased to give any further information desired.

Book Reviews.

Electric Power Plants, by Norman H. Schneider. Size, 5 x 7½. 8 chapters, 275 pages and 200 illustrations. Published by Spon & Chamberlain, 123 Liberty St., New York City. Price, $1.50.

The second edition of this book has just been published in a new and enlarged form and contains much more that is of value and interest to the operating engineer than the first edition. The section on theory has been thoroughly revised, a complete chapter on standard wiring has been added, direct- and alternating-current motors have been given a special chapter, while the principles of alternators, transformers, modern testing instruments and storage batteries are each explained more fully.

This book, while intended as a handbook of practical information for those who are called upon to operate an electric plant without previous experience, contains much of value to the engineer. Its many tables and wiring diagrams make it a book of reference which even the most enlightened engineer could use with profit. Mr. Schneider has written a greater part of the book with the aid of notes taken while actually handling the apparatus described so that it gives information which could not very well be obtained in any other way.

Electric Wiring, Diagrams and Switchboards, by Newton Harrison, E.E. Size, 5 x 7½. 15 chapters, 275 pages and 105 illustrations. Published by Norman W. Henley Publishing Co., 132 Nassau St., New York City. Price, $1.50.

This book is written for persons who are in any way connected with the wiring around an electric plant, especially engineers, wiremen, foremen or electricians. It starts out by explaining the calculation of size of wire required for any kind of electric circuit, such as mains, feeders and branches. It then explains methods of wiring with cleats, moulding and conduit and the laying out of a conduit system. The design of switchboards is then taken up for shunt and compound wound-dynamos, panel switchboards, street railway switchboards and lightning arresters. The ground detector and method of locating grounds are explained, after which the design of single, two-phase, and three-phase circuits is shown in detail.

The book is clearly written and well illustrated. The writer is to be congratulated on sticking to good old formula $C = E \div R$ in place of the one very often used. So long as E means electro-motive force and R means resistance, so long should current be designated by C. The upper ten in electrical circles who changed the designation of current from C to I had better get back to the use of C, which is almost universally used among practical men. The book has other strong features to commend it and should be a good reference book for the practical man.

Cement Association Mourns.

It was with deep regret that the many friends and associates learned of the recent untimely death of Mr. W. J. Patrick, of Catasauqua, Pa. In the death of Mr. Patrick, Cement Association, No. 4, N. A. S. E., mours the loss of a member whose place it will be hard to fill. Mr. Patrick was not only one of the founders and the foremost member of the Association but was also a respected citizen in the community in which he lived. Fitting resolutions were drawn up by Cement Association recording their appreciation of him and a copy of these resolutions was sent to his bereaved family and THE PRACTICAL ENGINEER, whose sympathies are extended to them for this irreparable loss.

Trouble with Sand-Hole in Cylinder and Repairs.

EDITOR THE PRACTICAL ENGINEER:

My attention was called, the other day, to a small plant in a near-by town. It was the town's water plant and consisted of two 3,000,000 gallon pumps, one a cross compound flywheel type and the other a duplex three-cylinder tandem compound pump, piston direct-pressure type. A pressure of 60 pounds was maintained at all times on the mains that supplied the town. Only one of these pumps was required to supply the demand and one was kept in reserve, as is customary where the Holly system is used.

The triple-cylinder duplex pump had only been running a short time and had not yet been accepted from the builders at the time I was called to look it over and to try to find the trouble with it. On entering the engine room I met the engineer and he soon got things ready for a trial. While warming up the two jacketed cylinders, the intermediate and the low, he told me that only the day before he had a man from the builders there and the man said there was absolutely nothing wrong with the pump and that, being new, it was naturally stiff on one side and that all such styles of pumps work unevenly when started new.

The engineer suggested to the shop man that he ease off the plunger gland and see if it would benefit that side any, but when he did, he had to tighten it again because every time the piston traveled to the pump end, the piston would find contact with the cylinder and the cushion valves useless. The shop man went away without finding anything, but as soon as the pump was thoroughly warmed up, we began to make a thorough search for the trouble.

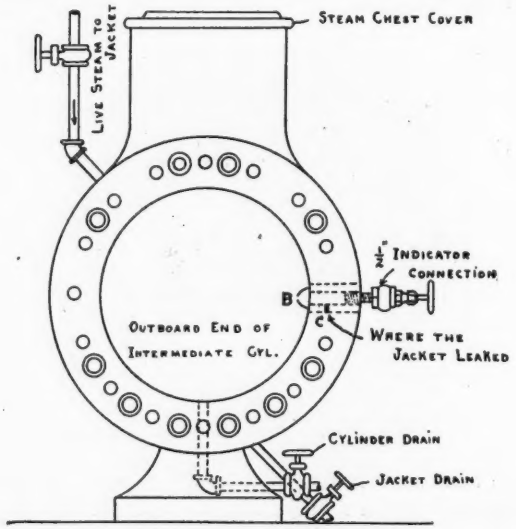
Taking the throttle in hand, after carefully starting the pump, I was quite sure that the shop man's idea was right, that the pump was working stiff, that all it required was the regulating of the steam valves at each high-pressure cylinder, each cross-exhaust valve from the high to the intermediate and from intermediate to low. I carefully arranged these valves for more than four hours but to no good purpose, for just as soon as the pump would increase its speed, the left side would strike at the inboard end of its stroke.

The pump was then shut down and after it had cooled sufficiently to allow for the taking off of the steam chest cover, I examined the high for valve leaks and valve position. In examining the valve for any possible leak, my method was to place the valve at the exact centre of its motion and then fill the steam chest with hot water. After an hour's time it had not leaked any, so that I was quite well satisfied that the valve was tight. In examining the valve for position, I placed the right-hand piston rod at the centre of its travel, thus placing the valve tappets of the left side at the centre of their motion, equalizing the lost motion between wrist block and tappets and the valve and valve clamps. I thus found the valves to be properly set.

The low-pressure steam chest cover was then taken off and the valves found to be properly adjusted. In doing this, I noticed that the low and intermediate cylinders were still quite warm and upon examination found that the valve in the steam jacket piping was leaking somewhat. The main steam valve to the pump was then shut off and a new disc was put in valve in jacket line. Taking off the steam chest cover of the intermediate I noticed some steam emitting from one of the ports. It soon occurred to me that as the jacket valve was leaking, the steam must come from a leak in the jacket of the intermediate cylinder.

To find the leak, I disconnected the jacket piping and drains from the other cylinders and arranged them so I could put steam in the jacket and let it out very quickly without waiting for the other cylinders to be warmed up. I turned steam into the left intermediate jacket and soon the steam was rising up through the outboard port. But where was the leak? Taking the inboard head off and the piston out, I put a lamp in the cylinder but it was soon extinguished by the escaping steam. The steam valve was then shut off, the drain valves opened and the jacket relieved of all pressure. The cylinder being entirely free from steam, I relighted the lamp, closed the drain valve and turned on the steam again. This time I discovered the leak in the indicator connection at the outboard end of the cylinder. The next thing to do was to repair it, which was done in the following manner:

Referring to the sketch, B represents the boss at the end



Repair to Steam Jacketed Cylinder

of steam jacket space where a hole is drilled for a ½-inch pipe. At C, a black line is shown representing the sand-hole which allowed the live steam to enter the cylinder through the indicator connection. To repair this, the nipple was taken out and the hole was very smoothly reamed with a slightly tapering reamer so as to have the hole small at the cylinder end of it. A bushing was bored ½-inch full and turned off sufficiently to fit the hole at B and just long enough to cover the sand-hole. This pipe was driven to place and the indicator pipe screwed in. When the boiler pressure was turned into the jacket again it was good and tight and when the pump was started up there was no trouble to cushion the pistons on either side.

Depew, N. Y. C. W. D.

The initial edition of the Harrisburg, Pa., Board of Trade Journal has just been published. It is a monthly publication devoted to the manufacturing and mercantile interests of Harrisburg, Pa. Being centrally located amid the iron and coal fields of Pennsylvania, Harrisburg contains many engine works, steel mills, boiler plants, pipe mills and other allied industries and it is the purpose of the paper to exploit these to the outside world. THE PRACTICAL ENGINEER wishes it success in its new undertaking.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

Mr. Wm. B. McVicker, Second Vice-President and Eastern Manager of the Dearborn Drug & Chemical Works, left on February 19th on a pleasure and business trip to Florida and Cuba. He will spend considerable time travelling throughout the Island, where the Company is doing an extensive business through their office at Havana. Mr. McVicker is accompanied by Mrs. McVicker. They expect to return about April first.

The Canfield Mfg. Co., 116 Lehigh Avenue, Philadelphia, are still offering to send a sample can of Ambest Packing to engineers who send them their full name and address, also by whom employed and the number of engines, with total horse power. This is an all-metallic packing which is adaptable to any stuffing box, large or small, where any kind of packing is needed.

The Penberthy book, issued by the Penberthy Injector Co., Detroit, Mich., is published for free distribution to engineers who are interested in Injectors, Lubricators, Oil and Grease Cups and other specialties manufactured by this old and well-known firm. A copy will be mailed to any engineer mentioning this journal.

The Gemmel Patent Boiler, built by the General Engineering Co., 764 Swanson St., Philadelphia, is an excellent and inexpensive boiler where small or moderate power is required. An illustrated circular will be mailed free to anyone interested.

The Youngstown Steam Trap Co. have published a new catalogue describing their new tilting steam trap, which they will mail to any of our readers. Requests should be sent to the main offices of the Company, Keystone Bank Bldg., Pittsburgh, Pa.

If you want to find out about a feed water regulator that is a wonder, write for a catalogue of the Copes Feed Water Regulator. It has been in use for years and wherever installed it is said to save considerable in the coal pile and not one cent has been necessary for maintenance and repairs.

The chief engineer of the Horn & Hardart Baking Co., of Philadelphia, writes as follows, under date of January 31, 1906:

Wilfong & Wiltbank,

420 Mutual Life Building, Phila.,

Gentlemen: In reply to your inquiry of even date, will say that we installed two Copes Boiler Feed Regulators two years ago in one of our plants at 818 Chestnut St. These regulators have given perfect satisfaction and have cost nothing for maintenance during that time and are today in as good condition as they were the day they were installed.

We also installed one Copes House Tank Regulator in the same building. We had previously tried several other house tank regulators, none of which worked satisfactorily. It gives me great pleasure to say that since these regulators were installed we have had absolutely no trouble with our house tank.

Yours very truly,

W. S. POLLARD,

Chief Engineer, Horn & Hardart Buildings.

One reason for its successful operation is the fact that it contains no floats or diaphragms, so that there is nothing to get out of order. It depends upon the expansive force of the water for its action, which is so positive that it is impossible for the level of the feed water to vary. Don't fail to write to the makers, Wilfong & Wiltbank, 420 Mutual Life Building, Phila., for a catalogue.

Two kinds of boiler flue scrapers, one kind of flexible shafting, a loose pulley lubricator and several kinds of oil cans and torches are shown in an illustrated circular sent us by the Gem Mfg. Co., Spruce St., near 33rd, Pittsburgh, Pa.

The American Boiler Flue Cleaner is a new apparatus for cleaning the soot and dirt out of boiler flues while the boiler is under pressure and without opening the doors and thus admitting cold air to chill the boiler. It is said that the whole operation only requires one or two minutes and practically no labor. A circular describing the apparatus will be mailed to those interested. Address American Boiler Flue Cleaner Co., 508 Broad St., Bank Bldg., Trenton, N. J.

Mr. W. B. Wilkinson, formerly supervising engineer of the Steam Boiler Equipment Co., of New York, and Mr. J. B. Hackett, for many years connected with boiler and engine room equipments, have associated themselves in business under the firm name of *Wilkinson & Hackett*, as general engineers and manufacturers' agents, in the special line of boiler room economy, at 428 Temple Court Building, Beekman and Nassau Streets, New York City.

They are putting the Wilkinson's Patent Accelerated Syphon Jet System for burning cheap grades of anthracite coal on the market, claiming equal results to mechanical or automatic systems at less cost; also the "Hydro-Carbon System" of smokeless combustion of bituminous coal, and the Wilkinson System of burning fuel or crude oil as a substitute for, or in connection with, coal. They are also representing as agents for New York and vicinity, the New England Roller Grate Co., of Springfield, Mass.; the American Boiler Flue Cleaner Co., of Trenton, N. J.; and the Standard Boiler Compound Co., of Bradford, Penna., and other high-grade specialties for boiler room economy, which their long experience has proved to be most efficient for the purchaser.

Twenty-three years' experience behind the up-to-date brains and plant of the Ohio Injector Co., of Wadsworth, Ohio, enables them to turn out injectors which have fine mechanical features, economy in the use of steam, reliability and ease of operation. They are manufacturers of the Chicago Injector, the Garfield Double Jet Injector, the Garfield Automatic Injector, the Ohio and Garfield Locomotive Injectors, the Garfield Ejector, and various styles of Chicago Sight-Feed Lubricators. Their latest catalogue describing these specialties will be sent to any engineer upon request and any information that may be desired relative to injectors or lubricators will be cheerfully furnished to any engineer mentioning THE PRACTICAL ENGINEER.

The automatic regulation of the feed water in boilers has become a known necessity in the modernly conducted plant. The essential feature in boilers of all descriptions is the factor of dry steam. To obtain this, it is necessary to maintain a constant unvarying water level, which should at all times remain at or a trifle below the centre gauge cock line.

The Williams Safety Feed Water Regulator is a well-known device of this nature, which gives the desired result. It is applied to over 4,000,000 horse power and within the past two weeks they have sold equipment for about 50,000 horse power; 6400 of this amount was shipped to the Jones & Laughlin Steel Company, who have used this regulator for four years, now having about 33,000 horse power equipped. Other purchasers were Mandel Bros., of Chicago, Carnegie Steel Co., Armour & Co., etc.

This regulator is manufactured by the Williams Gauge Company, of Pittsburg, Pa., who will be pleased to send one of their fine catalogues to any reader mentioning THE PRACTICAL ENGINEER.

The Williams Gauge Company have recently opened offices in the following cities: At 612 New England Building, Cleveland, Ohio, which is conducted by Mr. D. S. Tucker, and Room 3 Foulds Block, Winnipeg, Manitoba, Canada, conducted by Mr. M. O'R. Jarvis.

Any inquiries directed to these gentlemen for Williams Safety Feed Water Regulators, Steam Traps, Pump Governors and other goods, will receive careful attention.

The National Steam Pump Co., of Upper Sandusky, Ohio, have just issued a list of steam and power pumps manufactured by them. It contains much useful information and shows an extensive line of boiler feed, mine, double plunger and artesian well pumps. A postal card will bring one to you.

L. S. Starrett Co., of Athol, Mass., make a specialty of manufacturing tools of all kinds, such as squares, scales, calipers, micrometers, speed indicators, hack saws, protractors, nippers, screw drivers and the like. Their new catalogue 17 has just been issued, and it should interest every engineer.

Mr. G. Frank Duemler has resigned his position as Chief Engineer of the Northeast Manual Training School, Philadelphia and in future will represent the Dearborn Drug and Chemical Works, both in the engineering and sales departments. Mr. Duemler's long experience as an operating engineer will be of great aid to him in his new undertaking and his large acquaintance and great popularity with the engineers of this city insures his success.

If you want to know "Just Why You Should Use Ebonite" write for the booklet just published by the Quaker City Rubber Co., 409 Market St., Philadelphia. Innumerable tests of varying lengths and severity which this packing has undergone during the short time it has been on the market have shown it to possess very valuable properties for high pressure, superheated steam aand hot water service. A sample of "Ebonite" will also be sent to anyone mentioning THE PRACTICAL ENGINEER.

Mr. U. S. King, formerly with Williams Gauge Company, has recently withdrawn from the Company on account of ill-health, leaving Mr. John M. Williams in sole charge of their enormous business. In retiring, Mr. King desires to thank the former customers of The Williams Gauge Company for their valuable patronage, with the hope that any future business will still be directed to the Company, which will retain its same name.

A long-felt want in the shape of a union joint, which will not leak or rust and which requires no gaskets or attention, has recently been put upon the market by the Western Tube Company, of Kewanee, Ill., aand so great has been the demand for it that over one million were sold last year.

This union is called the Kewanee Union and the manufacturers would like every engineer to become acquainted with its advantages, so that they will send, free of charge, a Kewanee Union for examination and test.

Cut out the coupon found in their advertisement on page 47 of this issue and mail to the Western Tube Company, Kewanee, Ill., and a sample union will be sent you.

The Wetzel Mechanical Stoker Company, of Trenton, N. J., have just put in operation 1000 horse power Wetzel Mechanical Stokers for the Baltimore Refrigerating and Heating Company and have closed contracts for three 200 horse power Wetzel stokers for the York Manufacturing Co., York, Pa., and also three of the same horse power for the Hestonville Ice Plant, Philadelphia, Pa.

The success of this stoker is due to its scientific design and elegant mechanical construction and every one interested in the economical operation and smokeless combustion of soft coal plants should write for a catalogue.

"Engineers' Catalogue" is the name of a neat booklet just published by the New York Belting and Packing Co., 91 Chambers St., New York City. It describes the uses of their well-known Cobb's High-Pressure Spiral Piston Rod and Valve Stem Packings, for all classes of hard service, the Vulcan high-pressure spiral packing for high-speed work, the Magic rubber cushion packing, especially adapted for worn rods, the Amazon waterproof hydraulic spiral packing for cold water and high pressure, Elastic expansion ring packing for breweries, packing houses, ice plants, and cold storage plants, the Karbonite Black Sheet packing, the Indestructible White Sheet packing, the Ruby Sheet Packing and the Salamanda Sheet Packing for different classes of service. These and many other specialties are described in the catalogue which should be had by every engineer interested in packings.

Frank Toomey, of 127 N. Third St., Philadelphia, carries a complete line of second-hand machinery, including engines, boilers, steam pumps, gas and gasoline engines and dynamos. These machines have all been rebuilt and are kept in stock for immediate delivery.

A. D. Granger & Co., 95 Liberty St., New York City, have just issued their catalogue No. 3, describing complete power plants erected by them. They make a specialty of erecting power plants for hotels, office buildings, apartment houses, central station and isolated lighting and power installations. In plants of their own design they put in boilers manufactured by the Union Iron Works, of Erie, Pa., the Harrisburg Manufacturing and Boiler Co., of Harrisburg, Pa., and the Oswego Boiler and Engine Co., of Oswego, N. Y. Their engines are built by the Skinner Engine Co., of Erie, Pa., the Bates Engine Co., of Joliet, Ill., and the Frost Mfg. Co., of Galesburg, Ill. The Cookson Feed Heater and the Heisler Pumping Engines complete their lists of specialties. Any person intending to equip a plant should write to them for Catalogue No. 3.

The many testimonial letters which have been received by the Buckeye Boiler Skimmer Co., of Toledo, Ohio, indicate that their skimmers have found a warm spot in the hearts of those using them. A sample of these letters, from the Macbeth-Evan Glass Co., Pittsburg, Pa., written under date of January 20, 1906, follows:

Buckeye Boiler Skimmer Co., Toledo, Ohio.
Gentlemen: About a month ago we installed three Buckeye Boiler Skimmers in our boilers, at Marion, Ind., and it seems from reports we have received from our factory that these skimmers are giving entire satisfaction in every respect.

The factory writes they have not been troubled with foaming boilers, nor have they any trouble in keeping up steam.

They say that beyond any question the skimmers are a success, and it is wonderful the amount of sediment they blow out of the boilers.

Wishing you success, we beg to remain, very truly yours, Macbeth-Evans Glass Co.

This apparatus is explained in a neat catalogue and will be sent free to any engineer mentioning THE PRACTICAL ENGINEER.

The name "Gladiator" signifies strength and when that name was applied to the gaskets manufactured by the New Jersey Asbestos Co., of Camden, N. J., they were rightly designated, because they have never been known to blow out and they can be used over and over again without impairing their efficiency. Any reader mentioning THE PRACTICAL ENGINEER will be sent a sample, free of charge.

The Corliss Engine Works, of 4041 N. Fifth St., Philadelphia, make a specialty of indicating engines and making engine repairs. They have a complete and model shop for building and repairing engines and no job is too large or too small for them. Estimates will be cheerfully given upon all classes of repair work, indicating engines or valve adjustments.

The Platt Iron Works, whose Philadelphia office was formerly at 619 Arch St., have removed their office to the Commonwealth Building, where they will be pleased to receive their many customers.

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Lighting and Power Plants
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PATENTS PROMPTLY SECURED. Highest references from prominent manufacturers. Write for Inventors' Hand-Book, SHEPHERD & PARKER, 186 Deitz Building, Washington, D. C.

Wanted A few good and competent engineers along the Ohio, Mississippi and Kanawah Rivers, to sell the best thing on earth. This can be done after working hours and between times. Address
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521 Colburn Street, Toledo, Ohio

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory. Address
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A new preparation for enriching oils.
Will suspend in oil.
No more Hot Journals.
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A trial will convince you
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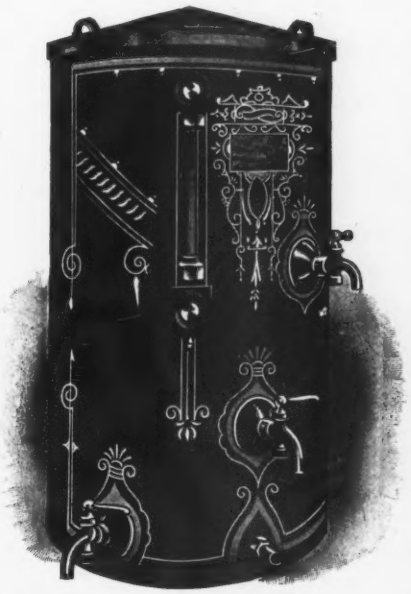
CROSS OIL FILTER

constitutes the best kind of a dividend-paying investment. It pays from the moment you install it in your plant by reclaiming all of your waste oil and making it as pure and good as when new.

Wherever **Cross Oil Filters** are in use, lubricating bills are reduced 50 per cent. or more, and this saving is important, no matter how much or how little oil you use.

Perfect materials, skilled workmanship and a complete knowledge of what a good filter should be, account for the fact that about 20,000 are in use today in all parts of the world.

Cross Oil Filters are sent on 30 days' trial, subject to approval.



THE OPINIONS OF USERS COUNT.

Pittsburg, Pa., March 16, 1904.

Burt Mfg. Co., Akron, Ohio.

Gentlemen:—In answer to your favor of the 15th inst., would say that we have in the past few years used a great many of your oil filters and purifiers, and they have given us very good satisfaction, and I have no hesitation whatever in recommending them.

Yours truly, Wm. D. Hartupee, C. E. & P. A.
Pittsburg Plate Glass Co.

Try a Burt Exhaust Head

and you will have no more spraying exhaust. It effectually eliminates that bothersome and expensive condition by retaining all the condensation, permitting only dry steam to escape.

Built of extra heavy iron, lapped, riveted and soldered, which makes it sufficiently strong to last a lifetime.

SENT ON 30 DAYS' FREE TRIAL.

A SATISFIED USER.

Glen Ridge, N. J. Oct. 22, 1903.

Burt Mfg. Co., Akron, Ohio.

Gentlemen:—The Burt Exhaust Head which we have had in use for about five months serves its purpose admirably and is giving entire satisfaction.

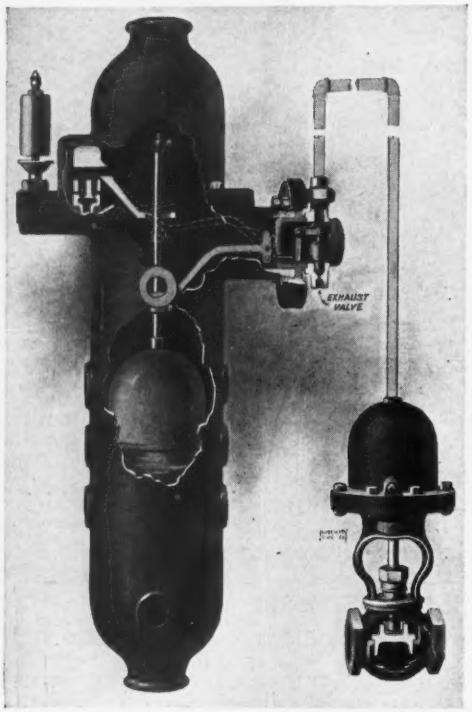
Yours very truly, Edison Storage Battery Co.
Reynold Janney, Manager

We have recently issued a new 48-page catalogue, which contains full descriptions of our various types of Filters and Exhaust Heads. We have a copy for every engineer interested in the subects. Have you yours? When writing state whether your plant is equipped with a Filter or Exhaust Head and give h. p. of engine.
We also manufacture the "Burt" Ventilator. Send for 20 page booklet.

The Burt Mfg. Co. Largest Manufacturers of Oil Filters in the World. **204 Main St., AKRON, O., U.S.A.**

Also Supplied by Engine Builders, Dealers and Power Contractors

Irregular feeding is bad for a boiler, it causes frequent contraction and expansion, destroying the ductility of the boiler plate and increasing the liability of explosion. Large "doses" of water requires sudden large quantities of fuel and every engineer knows that irregular firing is wasteful. More than ninety per cent. of all the boiler explosions that ever occured were the result of irregular admission of feed water supply.



The Williams Automatic Safety Feed Water Regulator

maintains a constant water level which cannot vary more than about one half an inch, thereby permitting economical firing. This splendid automatic device rises superior to human frailties and besides paying for itself about twice annually in fuel, dry steam, and saving of repairs, it protects its users against boiler explosions.

Over three million H. P. boilers in the better class of steam plants are operated daily by the Williams. It has a record of eight years without a repair, and no body ever heard of a boiler explosion where the Williams was in service.

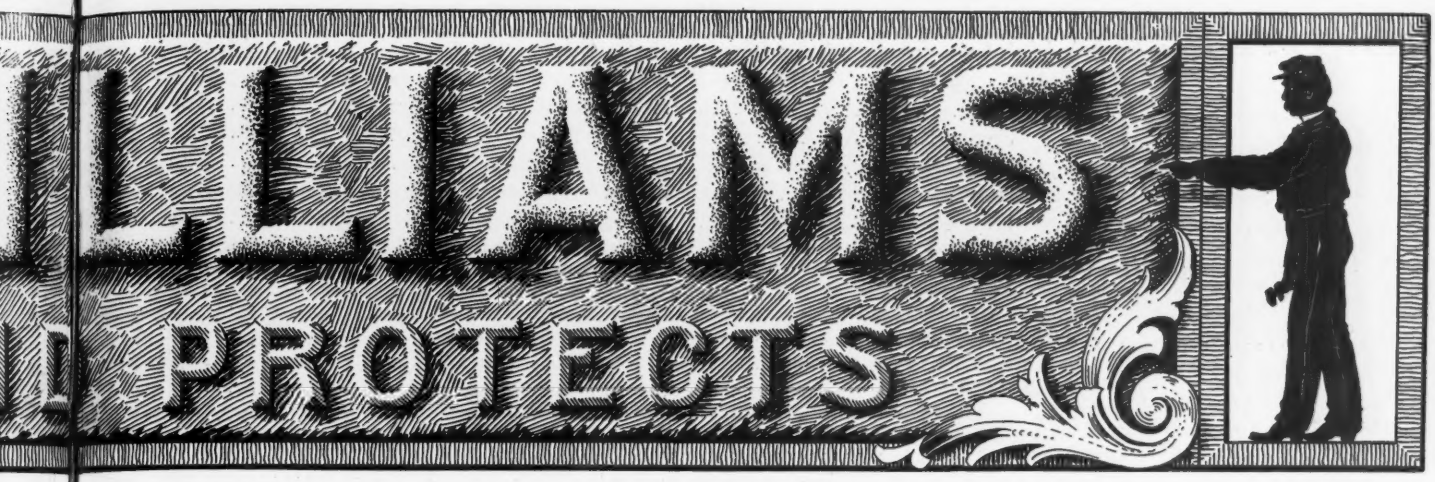
Steam users who do not adopt the Williams will pay its cost many times over to the coal man.

Our Catalogue is interesting, instructive and FREE to all who ask.

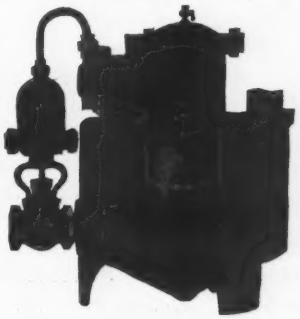
"I luv a rooster for tew things— one iz the krow that iz in him, and the other iz the spurs that air on him to bak up his krow with."
John Billings

The Williams Gauge Co. Pi

New York Office, 39 Cortlandt St. Philadelphia Of 710 Gir

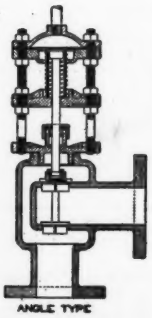


The Williams Steam Operated Trap



has a greater delivery and a greater and more positive discharge than any other trap. It blows the water out like a shot from a gun and closes just as quick. There is no waste, no dripping and spitting. No wire drawing or cutting. No matter how low it is placed its discharge is strong enough to throw the contents to the height of an ordinary two story building. Its action is positive. There is absolutely no trap duty it will not perform. It will do the work of three or four ordinary traps and do it better. Try one; if you don't like it, send it back.

The Williams Steam Pump Governor



will operate under the worst conditions on a variation of less than two pounds pressure. Can you depend upon the governors you are using to do as well? It allows the water to run uniform all the time and it will operate in any position. It is made flanged or screwed and for any type of steam pump. It is simple in construction having few parts and nothing to get out of order, and it is the easiest of all pump governors to adjust. Since we first offered this governor to the public more of them have been sold than of all other makes combined. **The U. S. Government uses them**

ge Co. Pittsburg, Pa. U.S.A.

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Steam users who do not use The Williams Automatic Safety Boiler Feed Regulator must pay its cost to the coal dealer many times over.

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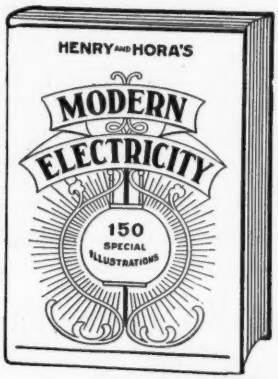

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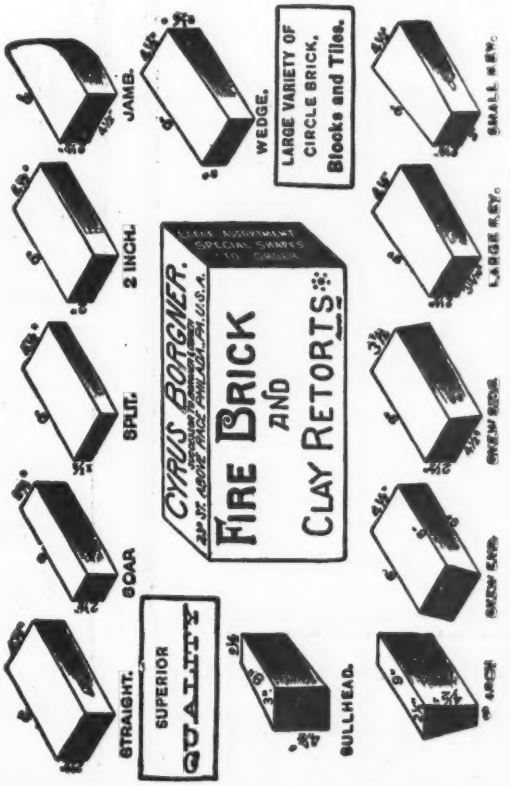

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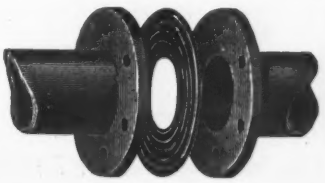

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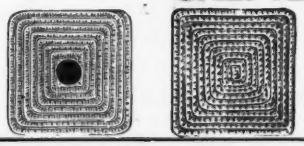

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Two (2) 150 H.P. Vertical Manning Boilers, 135 lbs. Steam.
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All first-class high pressure.
Steam Pumps up to 12" Suction.
Full assortment of Gas and Gasoline Engines.
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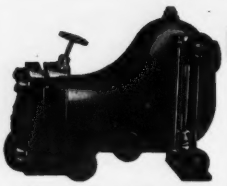

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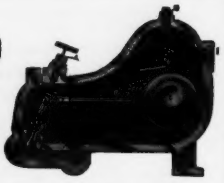

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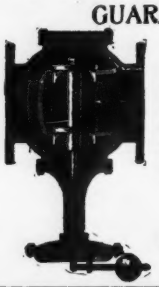

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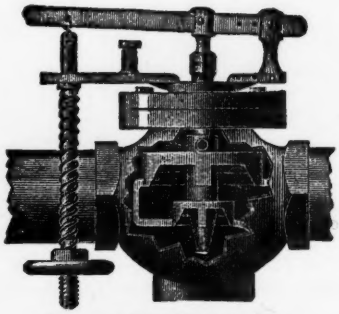

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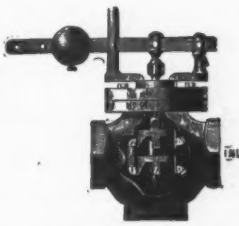

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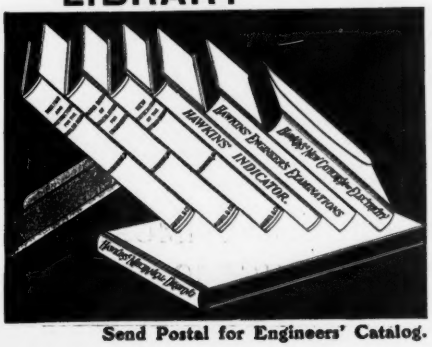

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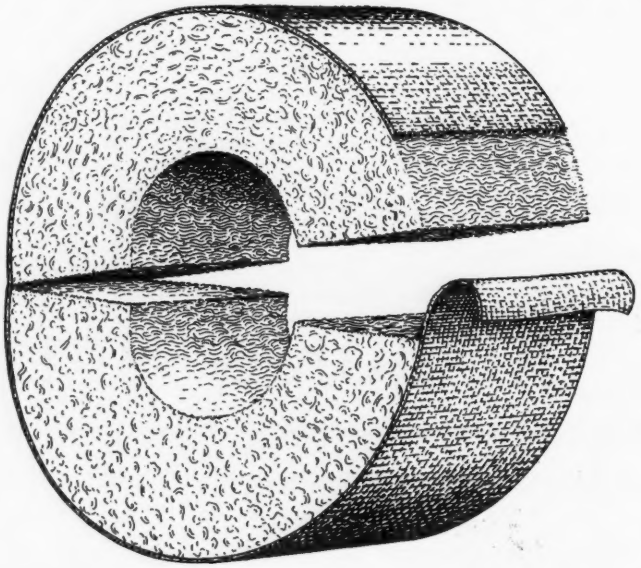

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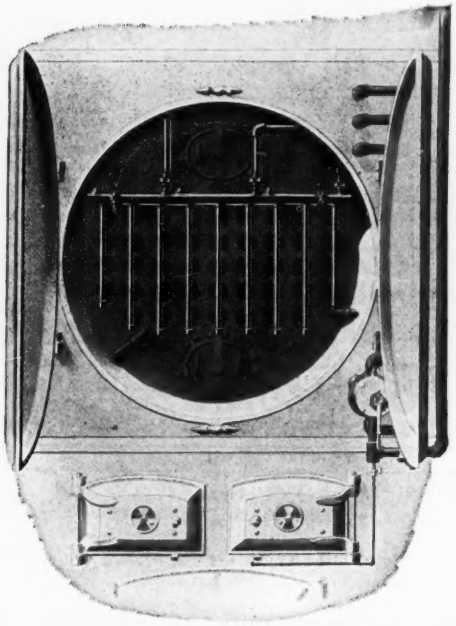

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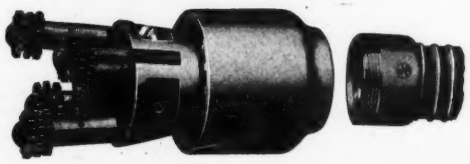

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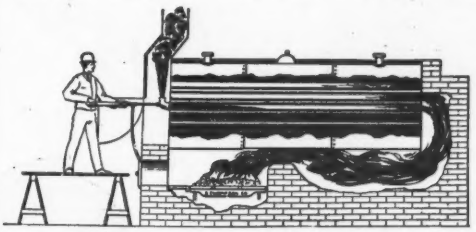

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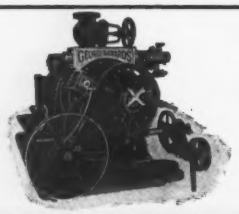

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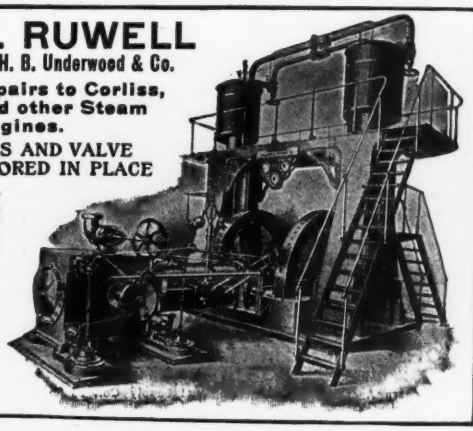

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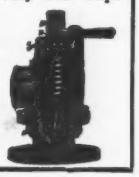

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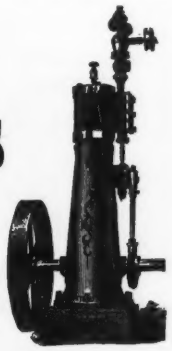

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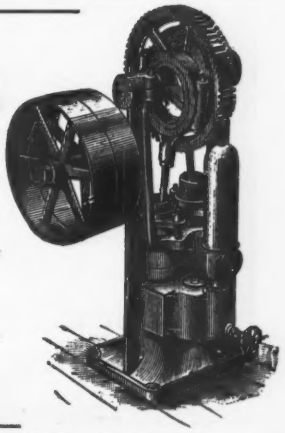

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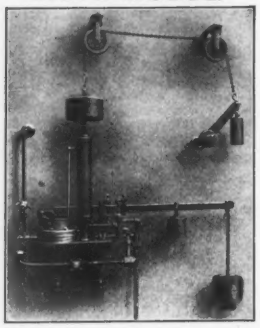

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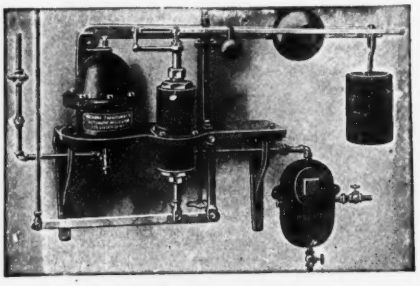

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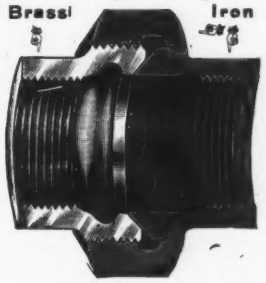

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Moderate in price.

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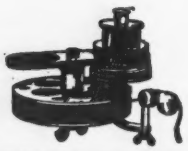

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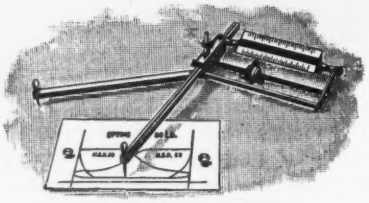

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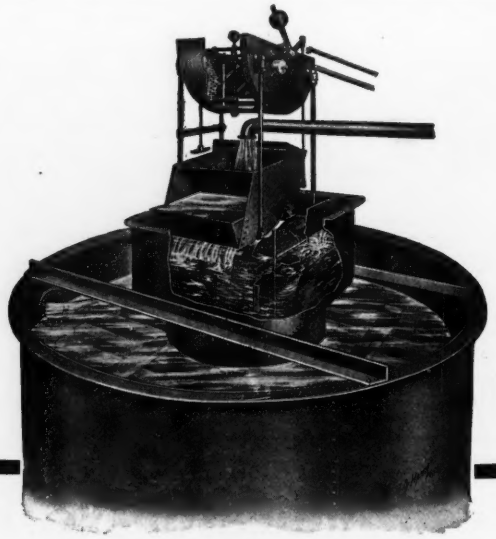

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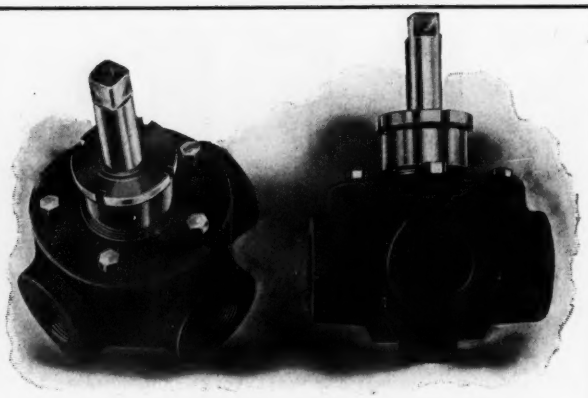

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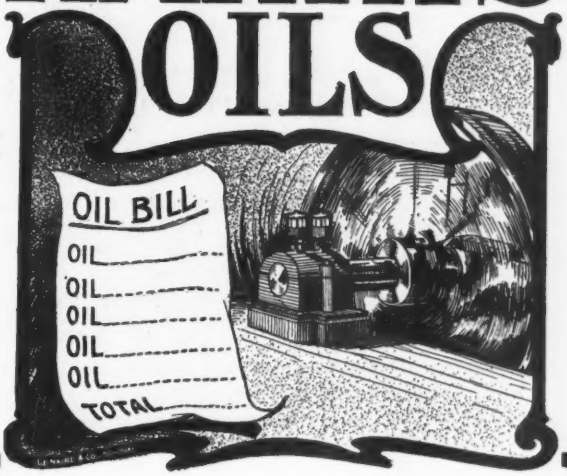

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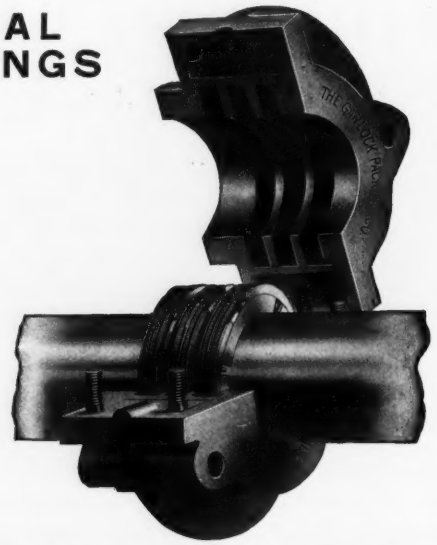

are made with a superior quality split case so that they can be applied to any type of engine without disconnecting the rod. The rings are so constructed that they will adjust themselves automatically to the rod and take up for wear, holding steam tight under the highest pressures with very slight pressure on the rod.

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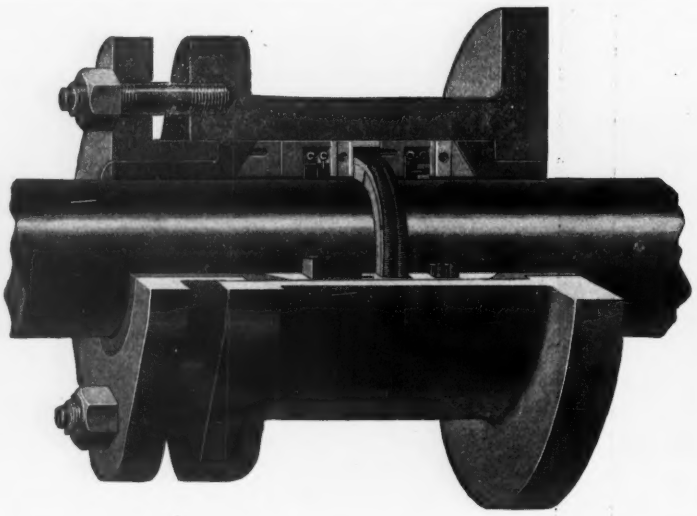

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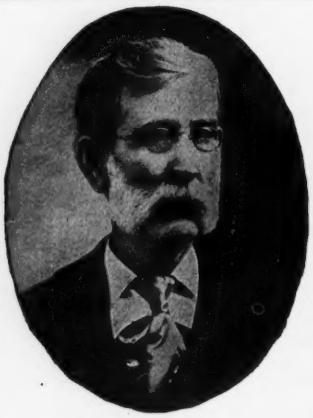

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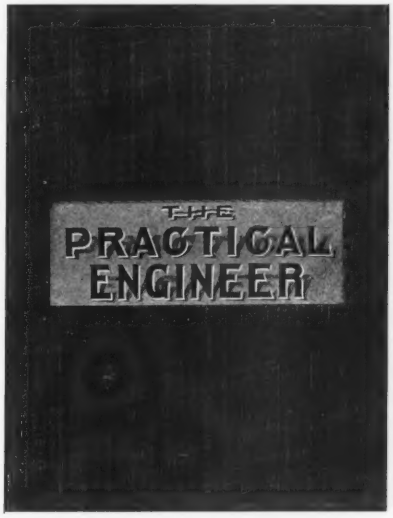

GOOD NEWS

We are very glad to announce to our subscribers that one of our salesman, Mr Frampton, has perfected a very neat cover that can be used to keep the copies of The Practical Engineer clean and in a usable condition.
One of the binders (as per the above cut) will be sent for 50 cents or with your subscription for $1.00, or we will send our binder FREE for three subscription at 50 cents each. Address Department 12.

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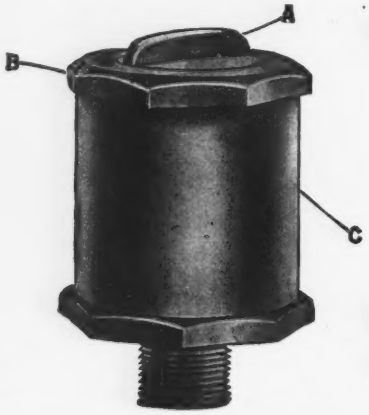

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More of them are sold than of all other makes combined.

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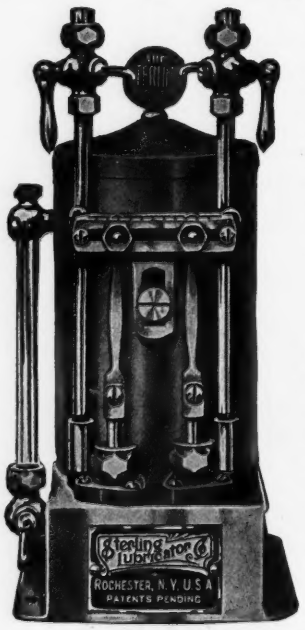

with the certainty of destiny is the way this lubricator oils your engine, pumps and other machinery to which it is attached. It does not deliver a small amount of oil one time and a large amount at another it delivers the right quantity, to the right spot, at the right time.

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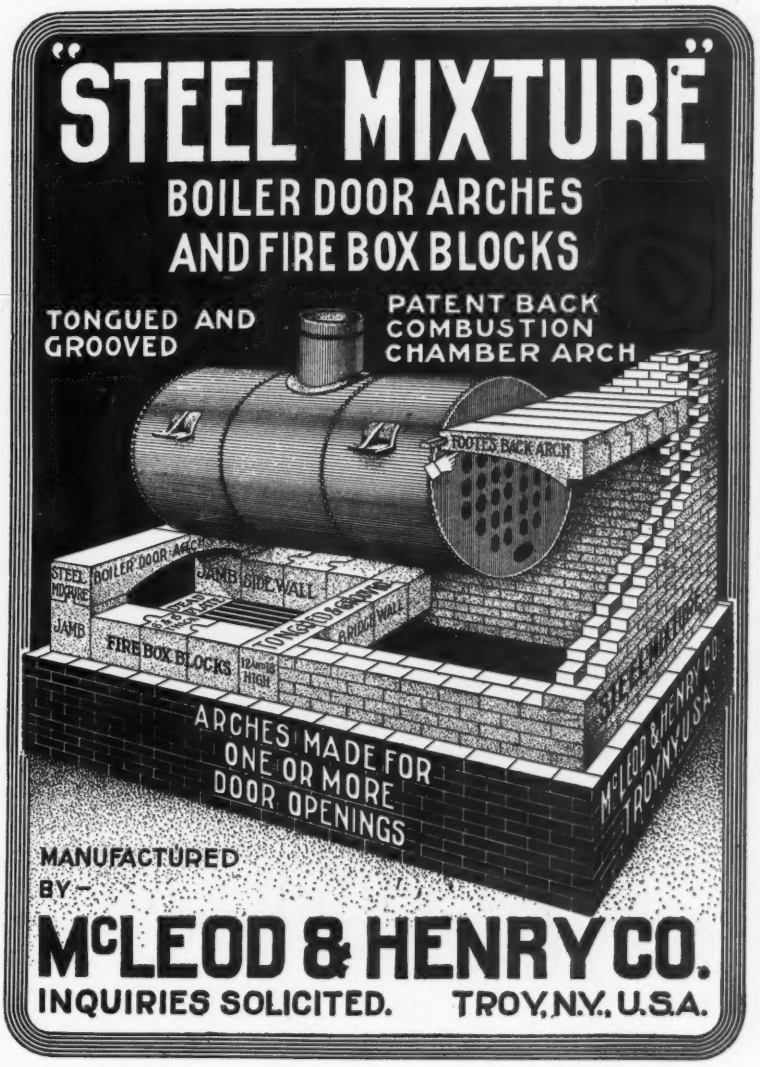
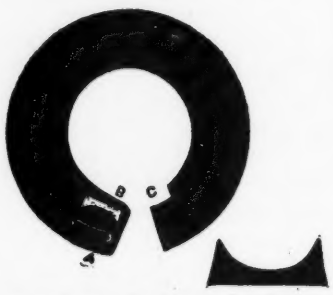


Walsh Metal Face Packing



A—Fibrous Packing. **B**—Metal.
C—Open space to avoid butting when cover is worn off.
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Adapted to all kinds of Steam and Water Packing. Will not cut Rods, will not wear rods to shoulder, will not harden under compression. More durable than fibrous packing. Less friction, as it is lubricant of itself. For packing engines, steam hammers, cranes, valves, expansion joints, pumps, elevators, accumulators, hot-water plunger pumps, etc. **Cotton, Linen and Square Flax Packing in Stock.**

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Can be used from 10 to 40 times.
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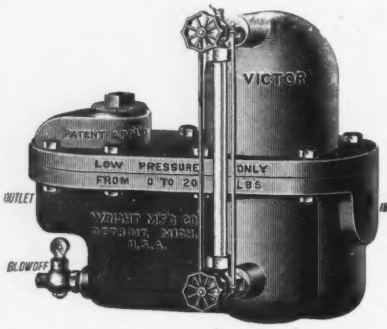
For Steam Pressures from 0 to 20 pounds only

Outlet valve approximately as large as connecting pipe, giving greater discharge than by any other trap yet designed. For heating systems and other low-pressure work we guarantee absolute results.
Material first-class, workmanship perfect.



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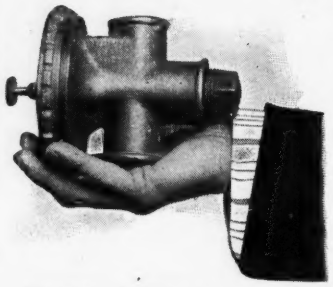

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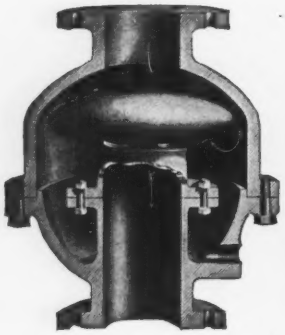

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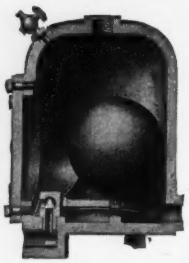

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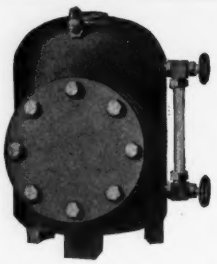

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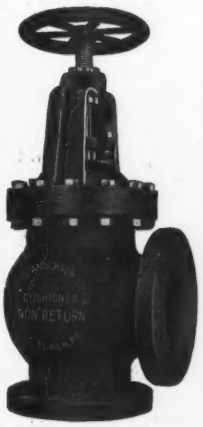

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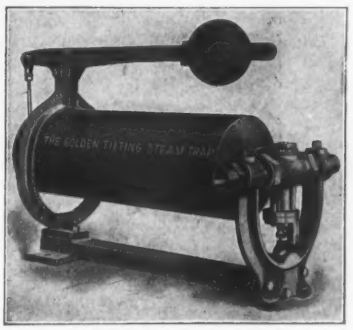

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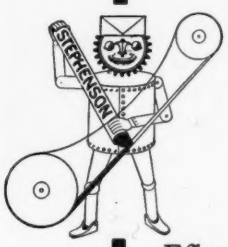

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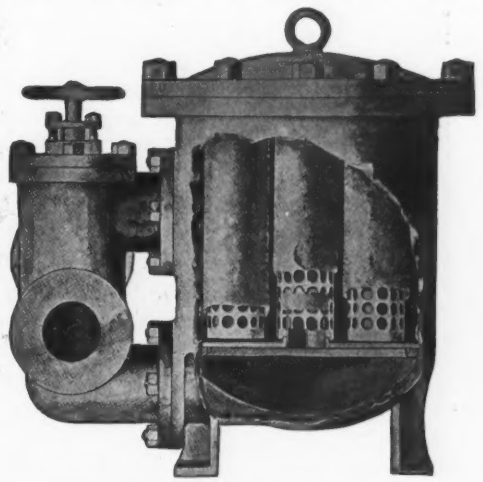

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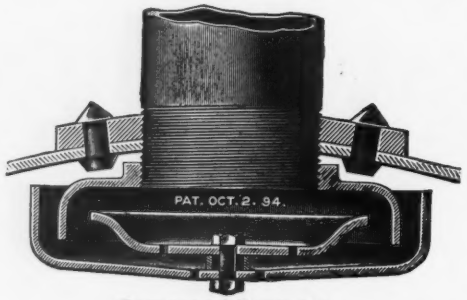

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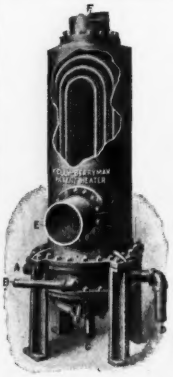

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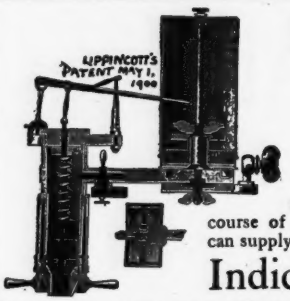

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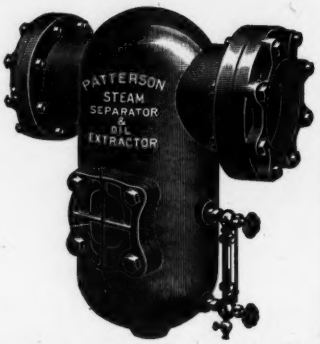

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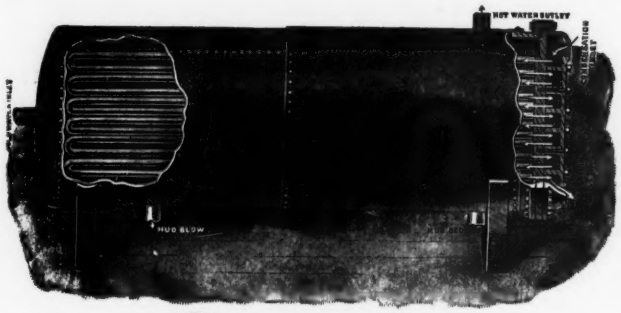

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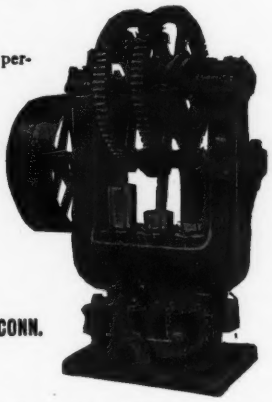

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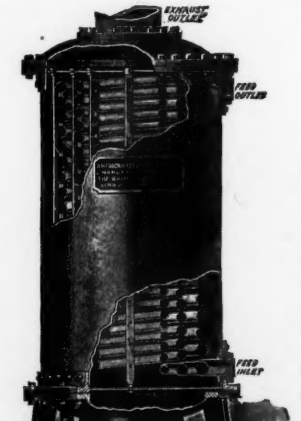

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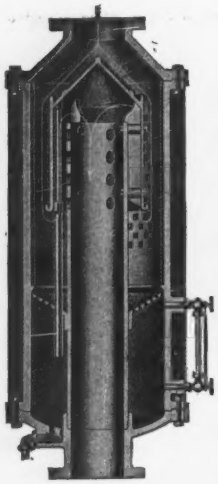

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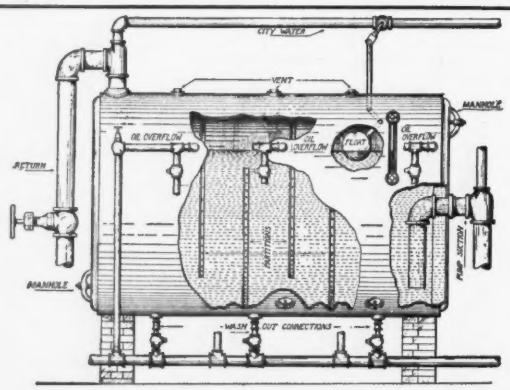

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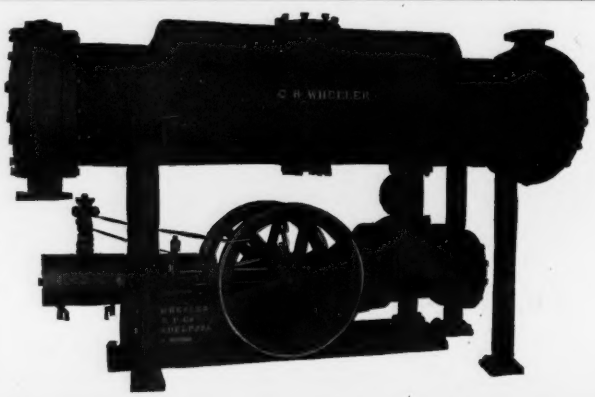

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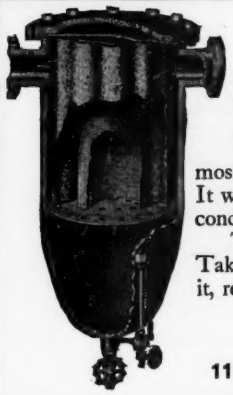

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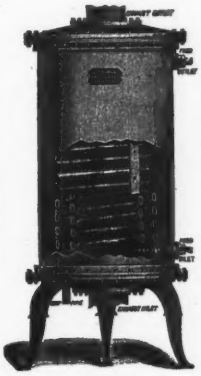

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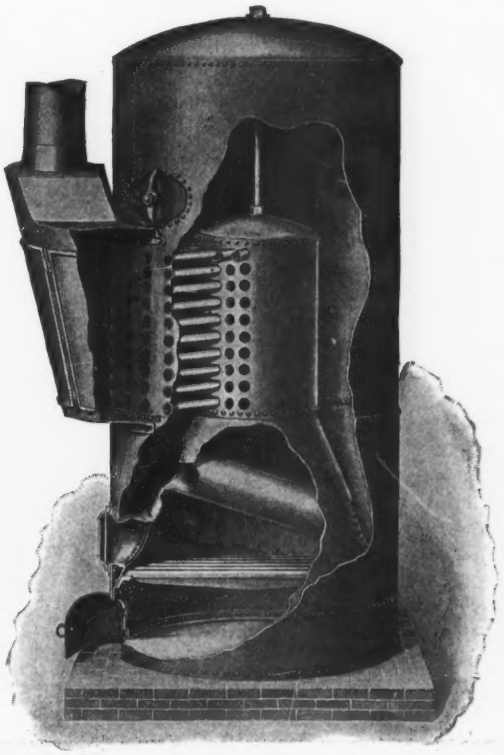

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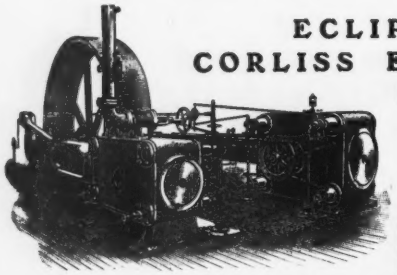

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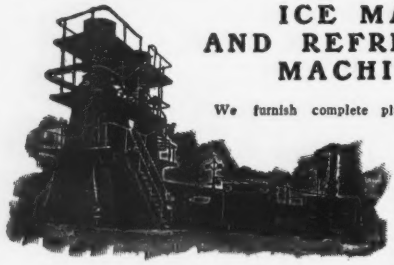

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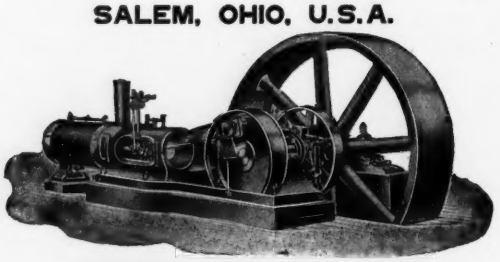

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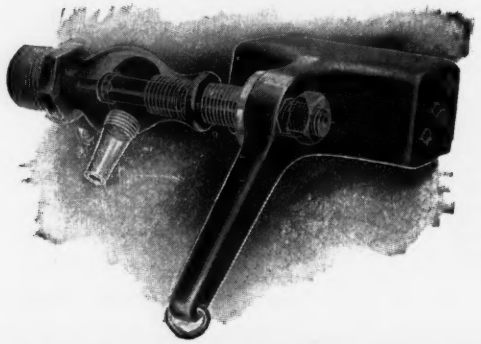
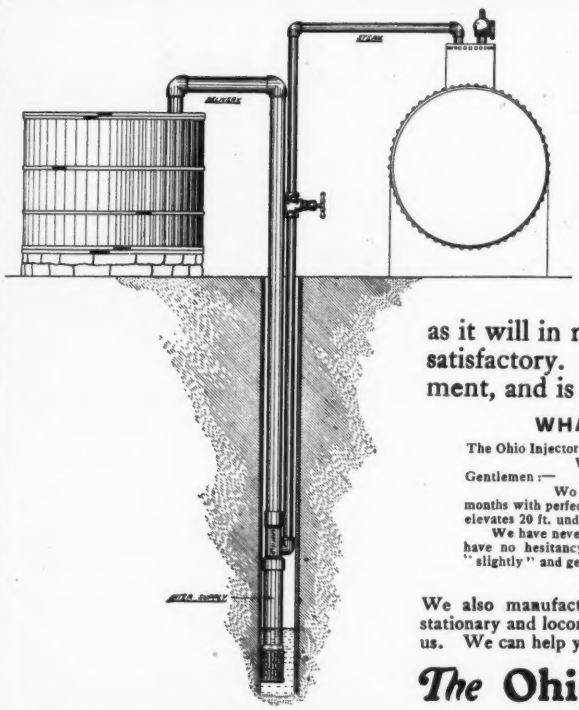


There is but ONE renewable part; the special metal valve pencil, which lasts for years and can be replaced for a few cents, in a minutes time. Thousands in use. Absolute satisfaction on high pressures.

THE PAUL B. HUYETTE CO., Inc. 1245 BETZ BUILDING PHILADELPHIA



Solve your water problem by installing a

Garfield Ejector

Almost anything and everything in the nature of a liquid (if not too thick) can be transported from one level to another, or horizontally, almost any distance. Factories, mills, mines, quarries, cheese factories, tanneries, etc., can readily see the advantage of adopting it in preference to a more expensive pump as it will in most cases, take its place and be just as effective and satisfactory. It is lighter and stronger, is not subject to derangement, and is always in working order.

WHAT USERS SAY OF THEM :—

The Ohio Injector Co., Green Bay, Va., Dec. 16, 1905
Wadsworth, Ohio

Gentlemen :—

Wo have been using two No. 3 Garfield Ejectors for about twelve months with perfect satisfaction. One of these ejectors has a lift of 24 ft. and elevates 20 ft. under 50 lbs. pressure.

We have never had an occasion to put one to a very severe test but would have no hesitancy in doing so. When we want water we turn on steam "slightly" and get it at once.

Very respectfully yours,
Hensel & Kauffman.

We also manufacture Injectors, Lubricators, Oil Cups, etc., for stationary and locomotive service. If you have injector troubles, write us. We can help you out. Catalogue free.

The Ohio Injector Company

2128 Main Street, WADSWORTH, OHIO

U.S. Automatic Injector

See that Drip Cock?

It is a distinctive feature of the U. S. Automatic Injector, and has these special and exclusive advantages :—

1—It drains the Injector when not in use, and thus prevents freezing.

2—By leaving it open you can start Injector even though the check-valve leaks. This is impossible without the Drip-Cock.

3—By opening Drip-Cock you can start with lower steam.

4—By leaving it open, when not in use, it prevents suction of pipe from getting hot, or jet from "liming up" when steam or check-valve leaks.

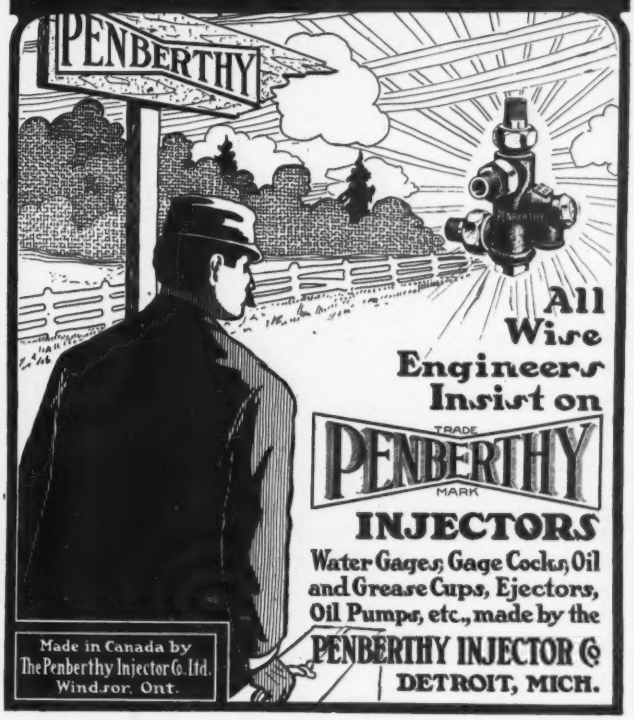
5—It enables you to take hot water out of a hot suction pipe on a long lift.

6—It is always handy for drawing hot water for any purpose when injector is working.

Write for the **Engineer's Red Book.** You need it and we will send it free on request.

American Injector Co. DETROIT, U. S. A.

FOLLOW THE ROAD TO SUCCESS!



All Wise Engineers Insist on

TRADE PENBERTHY MARK

INJECTORS

Water Gages, Gage Cocks, Oil and Grease Cups, Ejectors, Oil Pumps, etc., made by the

PENBERTHY INJECTOR Co

DETROIT, MICH.

Made in Canada by The Penberthy Injector Co. Ltd. Windsor, Ont.

The Truth About BRAIDED PACKINGS

There is one, and only one, braided packing—one, and only one, packing with a **gum core or center**—after which all others have been patterned, of which all others are imitations and nothing more.

"EMPIRE"

Gum Core Packing, invented by the late William M. Canfield, was **the only** gum core packing on the market in 1866, and it is still **the best.**

Why try to persuade yourself that other packings are, as claimed, "as good as 'Empire'"? Why not get the genuine "Empire" in the **first** place? Don't let your supply dealer give you any other.

This trade-mark is stamped in red on every few feet of the genuine "Empire". It is your protection against imitation and inferiority—look for it and **be on the safe side.**

MADE ONLY BY THE

CANFIELD MFG. CO., Ltd.

PHILADELPHIA

and sold by all first-class dealers in Mill, Engineer and Mining Supplies in all parts of the world.

Do you have a **Brown Core** in your Ice?

WE CAN CURE IT

100 Ice Plants

Use The Just Mechanical Boiler Cleaner
We will show you Why at our expense
Send for Descriptive Matter

Do you have **Scale** in your Boiler?

WE CAN CURE IT

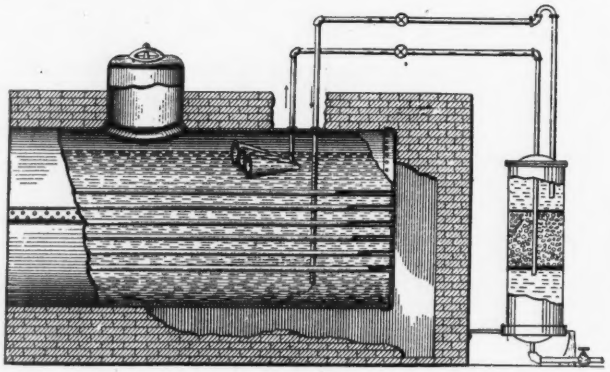
Do Not Spoil Your Output With Boiler Compound

We guarantee that you can run an entire season without shut down to clean boilers when the Just Cleaner is used.

Others Do It
Why Not You

No trouble.
No yearly compound bills.
No burnt tubes or sheets.

TRY US



The Just Mechanical Boiler Cleaner will clean your boilers of scale, will clean your ice of discoloration and

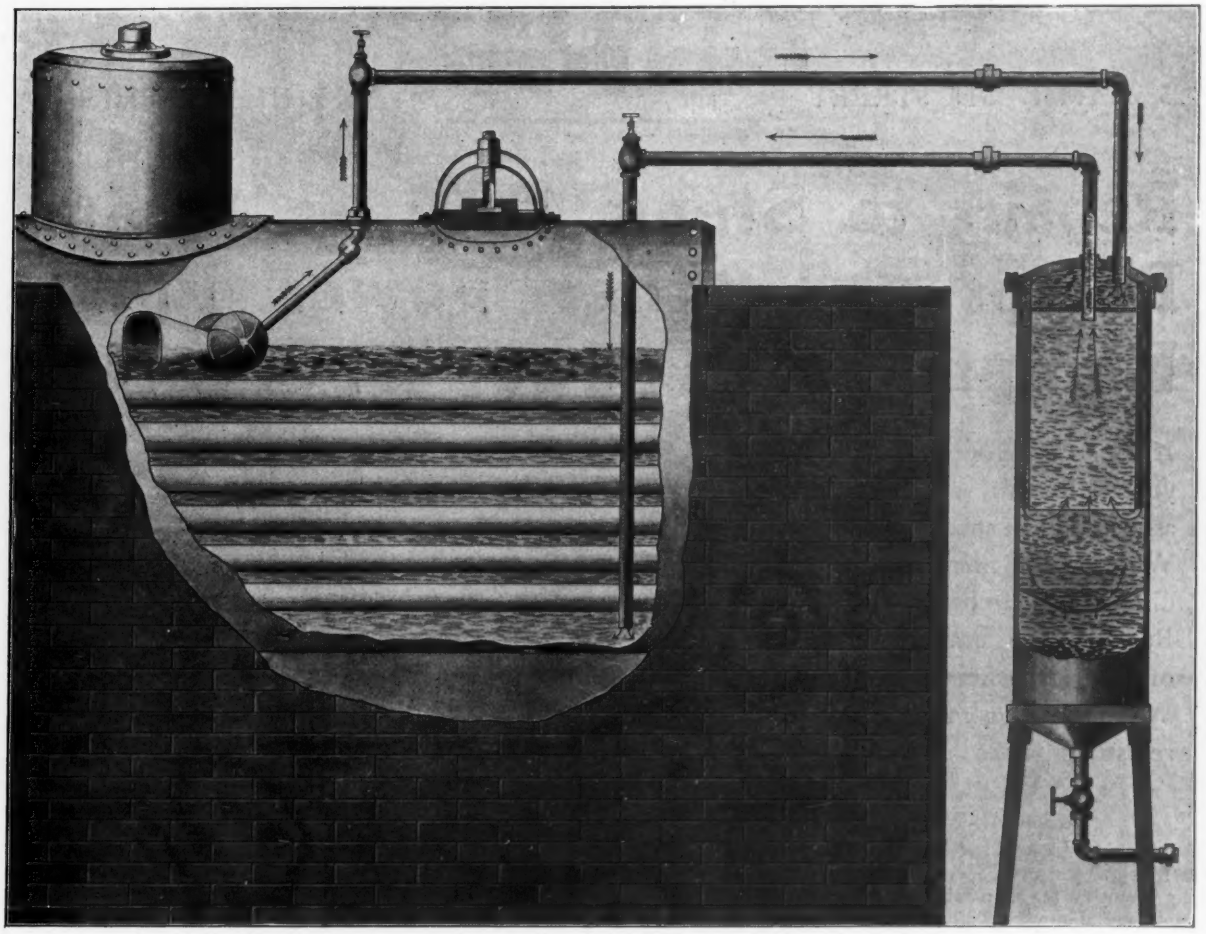
Bad Taste

and will keep right on doing it as long as your plant is in operation.

Give Us a Chance To Prove It

Just Manufacturing Company, 1215 FILBERT STREET, PHILADELPHIA, PA.

A Perfect Boiler Cleaner



THE ONLY BOILER CLEANER THAT HAS A FLOATING SKIMMER

The old way of permitting a boiler to accumulate heavy scale and then purging it with chemicals is rapidly being replaced by the **BUCKEYE AUTOMATIC BOILER SKIMMER** which keeps the boilers clean all the time and capable of developing their full capacity at all times with a minimum of fuel. It removes all the impurities from the water and deposits them in the filter, from which the pure water is returned to the boiler still hot, leaving the refuse in the filter to be blown off at the pleasure of the engineer.

The **FLOATING SKIMMER** is always at the water level and always working to its full capacity. The Buckeye is the only boiler cleaner with a floating skimmer and therefore the only one that removes the impurities all the time.

It is the cheapest known method of cleaning boilers. First cost is only cost. It pays for itself in a few months and then saves money every minute.

Write us today stating number of boilers with capacity of each and we will tell you the exact cost of keeping them clean.

We Install Them On Trial. **Our Big Catalogue Is Free.**

The Buckeye Boiler Skimmer Co.,

COLBURN AVENUE, TOLEDO, OHIO

DANIEL W. PEDRICK.
MORRIS G. CONDON
ALBERT D. PEDRICK
EDWIN J. ROOKSBY
Superintendent

L. B. FLANDERS MACHINE WORKS.
ESTABLISHED 1870.

Sole Makers of
ST. JOHN SELF ADJUSTING
CYLINDER PACKING.

H. B. UNDERWOOD & CO.
GENERAL MACHINISTS,
1025 HAMILTON STREET PHILADELPHIA, PA.

Repairs to Steam Engines, Steam Pumps and other Power Plant Equipment is our Specialty.

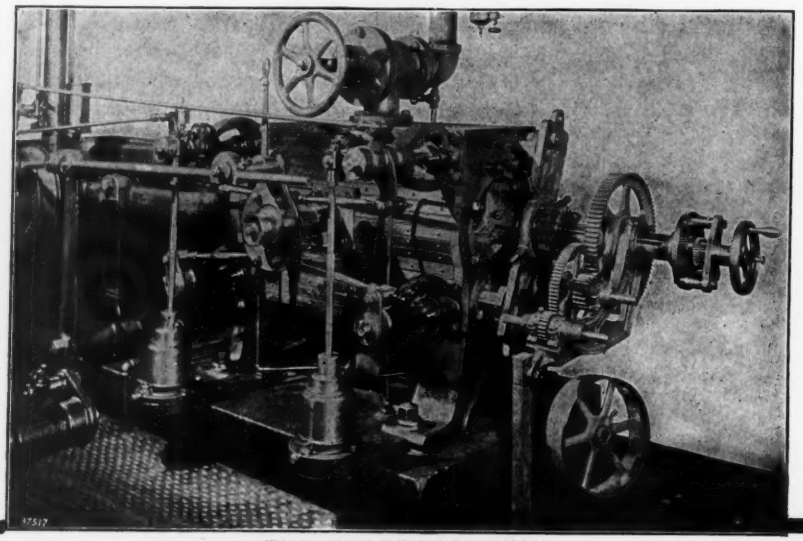
If your engine or pump breaks down, day or night, no matter what the conditions are, or where you are located, send for us. We have the largest force of expert mechanics and the largest assortment of special repair tools and machinery to be found anywhere in North America. We send the men and the tools and the machines direct to the job. You don't need to dismantle your heavy engines and pumps, we do the work on the spot.

But don't wait until your engine breaks down. An ounce of prevention is better than a pound of cure, let us keep your plant in repair all the time, the saving in fuel will more than pay you. We rebore cylinders of any size in position and we have a special machine for reseating valves in position.

SOME OF OUR OTHER SPECIALTIES

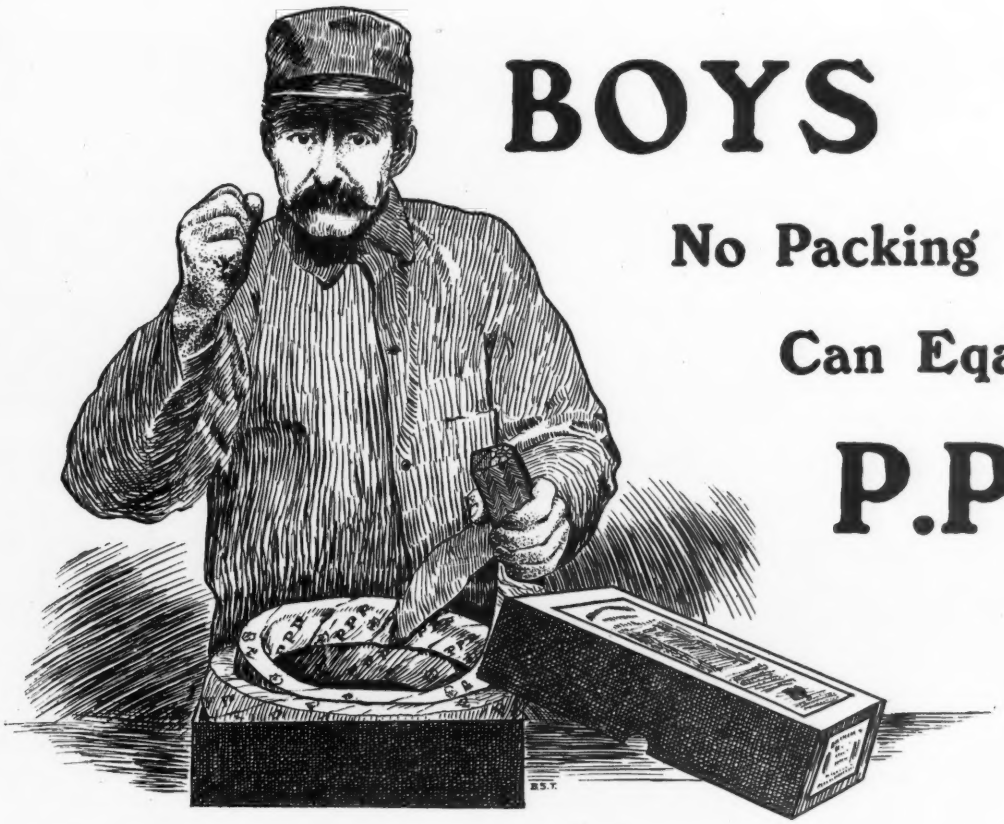
Gear Cutting, Internal and External.
Ice Machine Repairs a Specialty.
Sole Agents for St. John Self-Adjusting Cylinder Packing.
Crank-Shaft Journals of all sizes turned off without removal.
Send for our Book of Useful Hints for Engineers.
Dynamo Commutators Turned Off Without Removal.
Builders of Dash Pots.
Portable Planer for Facing Off all Sizes of Hammer Blocks in position. All kinds of Steam Hammer Repairs.
Blacksmithing. Steam Power Hammer.

SEND FOR US



SEND FOR US

THE UNDERWOOD WAY



BOYS

No Packing Can Eqaul

P.P.P.

Some packings have self-lubricating qualities of a high order—others will pack a scored or bent rod satisfactorily—and still others maintain their elasticity to a marked degree—but P. P. P. has all these qualities—and more—**it has an individual method of absolutely avoiding unnecessary friction!** As friction is the "GREAT DESTROYER" of Packings, the value of P. P. P. over other packings is apparent.

Just the other day the Engineer of a large Printing Press in Omaha wrote us, that, being bothered with solid packings which wouldn't last six weeks, he packed with P.P.P. and six months later there were no signs of wear or leakage.

And a Carpet Company in Lowell, Mass., wrote that P. P. P. had cut 50 per cent. off their packing bill and the same amount off their repair bill. These are not exceptianal instances; nearly every day we receive just such letters.

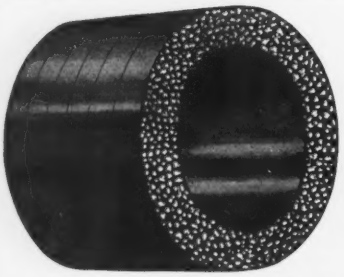
It is Friction that wears out the Common Packing—it is Friction that makes the big repair bills—and it is P. P. P. that prevents Friction!

Today—before you forget—drop us a postal for that special booklet on P. P. P. It's worth reading twice. Address Dept. "E".

CAUTION—The remarkable success of P. P. P. has brought out many imitations which unscrupulous makers claim have the fine qualities of P. P. P. We caution you against these imitations! To obtain these qualities you must insist on the original and only genuine P. P. P.

Quaker City Rubber Co.

PHILADELPHIA, PA.



Larkin's Self-Lubricating Metallic Packing

is the easiest packing ever made to fit into a stuffing box, and also the easiest to take out. It can be taken out and put back a dozen times and will be just as good the last time as the first. But you will not need to take it out. It will last as long as your engine, and will hold the highest pressures. It is the best packing of the century.

SOLD ON A GUARANTEE. ASK FOR BOOK.

Pennsylvania Electrical & Railway Supply Co.

General Sales Agents

PITTSBURGH, PA., U. S. A.

THE HOLLAND COMPANY, Chicago, Ill. San Francisco, Cal., and Denver, Colo.
W. B. BEAMER, Beaumont, Texas. E. A. KNOWLTON, Boston, Mass.
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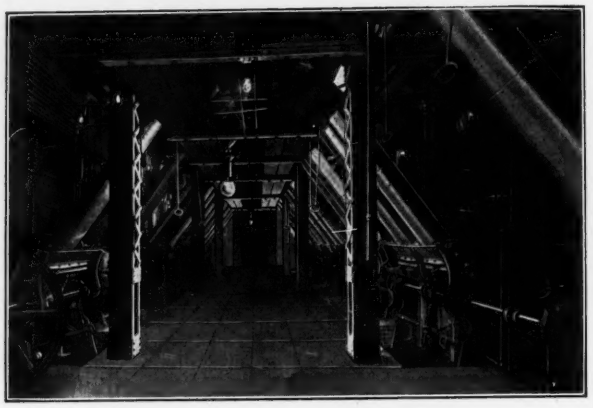
JUST MFG. CO. Philadelphia, Pa. G. A. HOSMER, Buffalo, N. Y.
WILLIAM MARTIN, 10 Barclay Street, New York, N. Y.

The GREATEST STOKER



The Boiler Room shown above is equipped with **Wetzel Mechanical Stokers** which are saving $957.00 a month in labor, and over ten per cent. of fuel. Thirteen consecutive orders from one company attest its value.

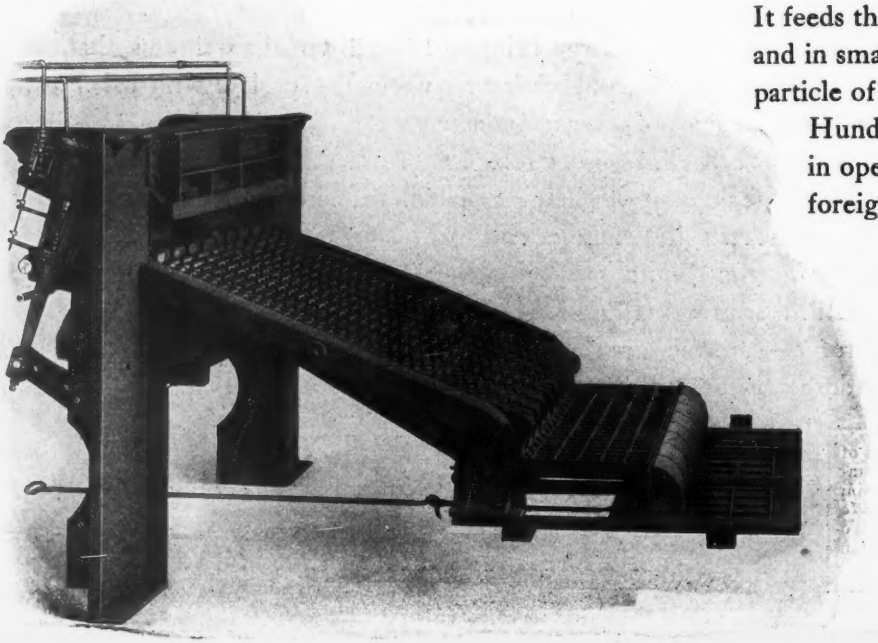
WRITE FOR CATALOGUE AND COMPLETE INFORMATION

The Wetzel Mechanical Stoker Co.

147 East State Street, TRENTON, N. J.

The Wilkinson Automatic Stoker

will Abolish the Smoke Nuisance



It feeds the fuel automatically, constantly and in small quantities as required; every particle of the fuel is burned.

Hundreds of Wilkinson Stokers are in operation in all parts of this and foreign countries, all of which are producing highly satisfactory results. If you have never investigated the advantages of this splendid and highly efficient Stoker write us for Catalogue and full information.

WILKINSON MFG. CO.

BRIDGEPORT

Montgomery County, Pa.

Keystone Grease

The World's Greatest Lubricant

FREE

CAN—CUP—CAP

We leave it to you to compare any oil, grease or lubricating compound in the world with KEYSTONE GREASE.

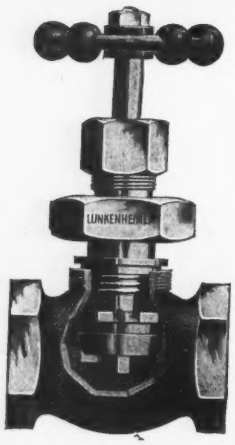
We want to let you see for yourself, that one pound of KEYSTONE GREASE will lubricate better and last longer than 3 to 4 pounds of any other grease or 4 to 6 gallons of high grade oil; and for this reason we will send FREE— (no charge now or afterward) to any engineer who will send us his name and business address, a large sample Can of Keystone Grease, a Heavy Brass Grease Cup, and an Engineer's Cap express paid; all we ask is for you to test KEYSTONE GREASE and to test it thoroughly. Also send us size of tap in which cup is to be used, H. P. of engine, and R. P. M.

Keystone Lubricating Co.

DEPT. F.

PHILADELPHIA, PA., U. S. A.

LUNKENHEIMER
Regrinding Valves



Standard Among Steam Users For Half A Century.

No Additional Parts Required To Repair Them When Worn.

A Few Minutes Spent In Regrinding And They Are As Good As New.

If Your Local Dealer Cannot Furnish them, Notify us

THE LUNKENHEIMER COMPANY

Largest Manufacturers of High-Grade Engineering Specialties in the World.

General Offices & works CINCINNATI, OHIO, U. S. A.

BRANCHES:—New York, 26 Cortlandt Street.
London, S. E. 35 Great Dover Street.

We Manufacture a Complete Line of Brass and Iron Globe and Gate Valves, Lubricators, Injectors, Whistles, Pop Safety and Relief Valves, Cocks, Etc. 2 P. E.

Did It Ever Occur To You Why

Nonpareil Cork

For Pipe Covering or Cold Storage Insulation is so much more efficient than other Materials.

It contains no foreign bind, such as pitch, asphalt and shellac, which reduces the efficiency.

In "NONPAREIL" the NATURAL GUM OF THE CORK only is the binder.

JOHN R. LIVEZEY
1936 Sansom Street
PHILADELPHIA, PA.

Nonpareil Cork Works
105 Hudson Street NEW YORK

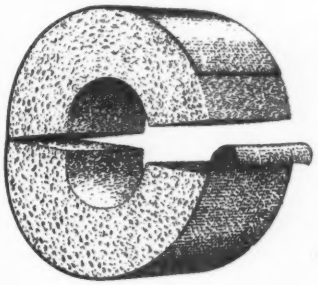
JOHN R. LIVEZEY
612 E. St., N. W. Washington, D.C.
L. P. MENCHINE, Mgr.

NORRISTOWN COVERINGS

LEAD THE PROCESSION

FIVE or six years ago Norristown Coverings were almost unknown outside of our immediate locality, now they are known in nearly every steam plant in America and used in most of them. Our factories which were formerly of very modest proportions are now among the largest of their class to be found anywhere and our output grows larger and still larger every month.

There must be some good reason for this remarkable growth, and there is. We do not need to tell our customers what it is, for they already know, and we do not have to tell engineers, for every engineer knows that there is but one thing that would cause such a demand for any brand of pipe covering and that is **Quality.**



If you have never used our high pressure Asbestos Magnesia Moulded Covering you ought to test it along with some other kind and see its remarkable efficiency. Next time you need covering in your plant, write us and let us tell you more about it and quote you prices.

We also made an extensive line of special coverings for low steam pressures, hot water, cold water, brine pipes, etc. Also a full line of felt, hair felt, asbestos air cell, corrugated paper coverings and mineral wool.

When any part of your plant needs covering, write us full particulars and we will send you an exact estimate of cost. Our prices are the lowest. Send for Catalog.

Norristown Covering Company

NORRISTOWN, PA.

TELEPHONE CONNECTIONS

BRANCHES

BOSTON NEW YORK PHILADELPHIA BALTIMORE
PITTSBURGH ATLANTA CHICAGO

Kick trouble through the window.
Bad packing is the engineer's worse enemy.
Try **"COBBS"** Piston Packing and **"INDESTRUCTIBLE"** Sheet Packing, and stop your kicking.

MANUFACTURED AND PATENTED BY

New York Belting and Packing Co., Ltd.

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Buffalo, 600 Prudential Building
Pittsburgh, 528 Park Building
Spokane, Washington, 163 S. Lincoln St.